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L1	RANDOM$2 ADJ3 SLECT$4
L2	historical adj interval
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L6	(RANDOM$2 and historical$2 and interval$2) and ((financ$4 portfolio) and (analysis value valuation))

30/9/1 (Item 1 from file: 16)
08354651 **Supplier Number:** 70659374

The Effectiveness of Automatic Inventory Replenishment in Supply Chain Operations: Antecedents and Outcomes.(Brief Article)

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Journal of Retailing , v 76 , n 4 , p 455
Winter , 2000
ISSN: 0022-4359
Language: English **Record Type:** Fulltext
Article Type: Brief Article
Document Type: Magazine/Journal; Refereed ; Trade
Word Count: 10320

Text:

The issue of buyer-seller relationships in supply-chain management research is becoming increasingly critical. Global competition and maturing domestic markets have driven supply-chain members to reassess their distribution techniques to remain competitive in the market. Firms need inventory replenishment systems that enhance customer service whereas at the same time reduce inventory costs. Many retailers are demanding time-phased replenishment. They want delivery made just as they need the stock for sale. High levels of anticipatory inventory are no longer acceptable. Retailers want high-volume, high-turn items delivered on a just-in-time basis. In this study, we investigate the use of automatic replenishment programs (ARPs) and the effectiveness of these ARPs in today's markets. Through a survey of U.S. retailers and manufacturers, we examine the transaction specific, strategic, and organizational antecedents that drive automatic replenishment efforts, as well as the effects of these efforts on the firms' s trategic and economic performance.

Global competition and maturing domestic markets are creating increasingly competitive conditions for channel partners, often necessitating a reassessment of distribution techniques (Siguaw, Simpson, and Baker, 1998). Trading partner relationships in the supply chain have received greater attention recently. Much of the attention has centered on the issue of inventory management. Many manufacturing firms have focused on the need for more effective management of production-inventory systems (Hahn, Bragg, and Shim, 1988). Many retailers have focused on time-phased replenishment rather than holding anticipatory stock (Andel, 1999).

Some of the more effective efforts at projecting demand levels have involved relationships in which sellers replenish or restock inventory based on the actual product usage and stock level information provided by buyers. These inventory systems have been referred to as automatic

replenishment systems, or ARPs. (1) ARPs are designed to make inventory commitment more efficient through precise planning and replenishment practices. Ideally, minimal stock levels are maintained without jeopardizing service levels. Automatic replenishment is most often associated with retail level inventory practices; however, ARP-type systems are applicable throughout the distribution channel. Retailers implement ARPs to trigger replenishment from manufacturers (or middlemen). In addition to the outbound connection with retailers or wholesalers, manufacturers may use the systems to manage inbound inventory replenishment from their suppliers.

One of the first high-profile examples of automatic replenishment involved Proctor and Gamble's involvement with Schnuck's Markets, a regional grocery chain in the St. Louis area. They later extended the ARP system to Kmart and Wal-Mart. Initial programs covered only soap products and disposable diapers. Today, more than 40% of P&G's sales to retailers are sold on automatic replenishment basis (Cooke, 1998).

Schnuck' s credits its automatic replenishment program for permitting significant reductions in inventory holdings. Standard demand forecasting was dramatically improved by working with actual sales data. However, the retailer still encountered stockout problems on promotional items. Their solution has been to increase automatic replenishment commitment by extending involvement to Collaborative Planning, Forecasting, and Replenishment (CPFR), which is expected to better forecast "big spikes in demand" due to promotions.

Because of their relative newness, little is known about ARP programs. However, the results of a preliminary investigation of U.S. firms currently involved in automatic replenishment programs presented in the following narrative provide greater insight into ARPs. The research focuses on antecedents influencing the effectiveness of automatic replenishment efforts. Additionally, the research examines the relationship between automatic replenishment effectiveness and firms' economic and strategic performance.

The paper is organized in the following manner. First, a theoretical foundation is proposed based on the existing literature. In this framework, we posit that automatic replenishment program effectiveness is driven by three functional perspectives of the firm: transaction costs, strategic philosophy, and organizational influences. Second, we develop a series of research hypotheses that link these perspectives with ARP effectiveness, and subsequently ARP effectiveness with the subjective and objective measures of firm performance. Finally, we offer a discussion of the research implications, as well as suggested directions for future exploration.

THEORETICAL FOUNDATIONS

Efficient replenishment systems require effective information linkages between buyers and sellers; sharing of information reduces uncertainty. A recent paper by Closs, Roath, Goldsby, Eckert, and Swartz (1998) reporting on an empirical comparison of traditional anticipatory (forecast oriented) and response-based supply chain systems (consistent with the ARP format) provides an excellent illustration of the benefits resulting from decreased uncertainty through utilization of automatic replenishment type systems. Response-based supply chain strategies were found to consistently outperform anticipatory systems in terms of both improved service and lower inventory holdings. More precise demand-oriented information resulted in substantial inventory savings.

The trade literature (e.g., Casper, 1998; Robins, 1995) provides examples of company-specific programs. For example, Efficient Consumer Response (ECR) is widely used within the grocery industry. Retailers such as Giant Food in Maryland credit the cooperative programs with achieving "immediate, significant reductions in inventory" (Garry, 1994). The retailers routinely work with manufacturers such as Kellogg and Nabisco to improve replenishment efficiency. However, automatic replenishment is not limited to the grocery industry. Apparel retailers such as Dillard's and JC

Penney utilize Quick Response programs to improve inventory efficiency (King and Maddalena, 1998).

Although a few case examples of ARP's are available, empirical investigations remain sparse. Little inquiry has been made into the antecedents, which drive replenishment effectiveness or the **value** of these systems. Previous research suggests that a number of changes in operating systems are associated with effective automatic replenishment programs (Cottrill, 1997; Fiorito, May, and Strong, 1995). These changes include reduction, efficiency, and reliability. Reduction in production run length, shipment sizes, and reliance on forecasting allows a firm to manufacture and ship in shorter time-spans. Reduction in order cycle length and smaller size shipments limit retail inventories. Thus inventory commitment is reduced throughout the supply chain. Efficiency comes in the form of receiver friendly loads, that is, delivery of exact quantities needed and/or configured to meet customer requirements. Efficiency also results from better communication linkages between buyers and sellers, which reduces waste of both ta ngibles and time. Reliability includes more predictable order cycles, which enable selling firms to ship and deliver goods on time and retailers subsequently deal with fewer out-of-stock items. More simply stated, these changes are captured in the cost reduction and service enhancements of the replenishment system. These dimensions of automatic replenishment programs are not necessarily mutually exclusive; firms will attempt to achieve some level of both in their systems. To do so, a considerable commitment of resources is necessary because ARP involvement demands significant **financial** and managerial inputs (Keh and Park, 1997).

In any managed inventory program, the issue of control in key supply decisions is critical (e.g., Gaski, 1984). The transfer of control of **financial** responsibility and asset management to the supplying organization provides a fundamental shift in buyer-seller relationships (Nannery, 1994). That transfer is an important aspect of this study: the transfer of control balance within ARP relationships requires an understanding and trust in the confidentiality of sales data and pricing information shared among organizations (Fiorito et al., 1995). Firms rely most heavily on information exchange in channel relationships characterized by high levels of interdependency (Frazier and Sommers, 1984). Control of the movement of tangible goods between supply chain principles is an obvious function of any ARP. Control of market-related information is equally important to organizations. Because of this major shift in control to the selling organization, our unit of **analysis** in this study is the most important ARP relationsh ip of the firm. Thus, the focus is on the ARP movement of goods within a critical organizational relationship.

We see three multidimensional perspectives as appropriate for discussing the control and resource issues associated with automatic replenishment programs: These are (1) transaction cost **analysis,** (2), the strategic considerations of the firm, and (3) organizational factors. The three perspectives are believed to influence the degree of ARP effectiveness and the role of ARP operations in the decisions of the supplying organization. Transaction cost factors are useful in understanding the problems associated with bilateral bargaining in individual relationships in dynamic environments (Aulakh and Kotabe, 1997; Kogut, 1988), which in turn enables us to investigate control related perspectives of shared systems. The strategic orientations of the firm allow investigation of the differing competitive postures of firms and their association with working ARPs. Concentrating on the organizational factors allows examination of the resource-related issues that are relevant to inventory management systems.

A dominant paradigm used to explore supply-chain relationships is based on transaction cost **analysis**. Although TCA provides a parsimonious theoretical explanation of these relationships, it focuses on individual economic exchanges (Aulakh and Kotabe, 1997; Williamson, 1975). There is a need to complement the efficiency perspective of the transaction

cost model with "strategic issues concerning governance modes, for it is argued that firms may be willing to sacrifice the cost advantages...in order to improve their competitive position vis-a-vis rival firms" (Aulakh and Kotabe, 1997, 146). This is also reflective of traditional supply chain management practices of balancing or assessing cost and service trade-offs.

Transaction costs **analysis** addresses the behavioral assumptions of self-interest and bounded rationality of the entities involved in supply chain relationships (Williamson, 1975). Shared information provides the opportunity for firms to behave opportunistically, which increases the transaction costs associated with the exchange relationship (Aulakh and Kotabe, 1997). High transaction costs often drive firms to increase control within the channel, and in an ARP context this can affect the balance of responsibility between buyer and seller. This is very similar to the channel integration arguments made by Anderson and Gatignon (1986), and Klein, Frazier, and Roth (1990), where enhanced transaction costs drove firms to increase their channel control by integrating distribution channels. Theory suggests that firms act in such a way as to minimize the sum of transaction costs and production costs (Klein, Frazier, and Roth, 1990). From the ARP perspective of transaction costs, the critical factors associated with cost minimization are systems standardization, underlying product costs, and market uncertainty in the form of competitive intensity.

The strategic considerations of the firm involve the relationships between organizational goals and the effectiveness of automatic replenishment programs. Traditionally, managed inventory arrangements have been used to reduce costs and thereby increase margins and revenues (Stratman, 1997). This would provide the profit-oriented firm with the motive to implement ARP strategies and subject itself to the related control and resource commitment issues of these systems. However, the strategic orientation of many supply chain members is toward the market, with goals of competitive differentiation and enhanced market share position. ARPs accomplish this by consistently providing an array of customers with on-time products, but with less emphasis on cutting costs. Thus, two strategic factors are relevant to the discussion: market and profitability orientation (Cavusgil and Zou, 1994; Porter, 1980). Market oriented strategy deals with meeting competitive moves within the market, creating barriers to entry, and other broad strategic aims associated with enhancing market position and meeting customer needs. A profit-oriented strategy instead focuses on revenues and therefore is more likely to be associated with costs versus time.

The third dimension associated with control and resource issues and ARPs is that of organizational factors. The capabilities of any organization will affect its ability to effectively move products (Day, 1994). This is particularly true when implementing sophisticated transfer systems such as ARPs. Capabilities are based on organizational structure and competence, and influence the organization's ability and management's willingness to invest resources in distribution decisions (see Madhok, 1996). According to Aulakh and Kotabe (1997, p. 148), "... a major distinction (exists) between transaction cost and organizational capability perspectives.., while the former focuses on the transaction characteristics to minimize the sum of transaction costs and production costs (Kogut, 1988; Klein et al., 1990), the latter deals primarily with firm capabilities in order to better manage its skills and resources." Successful implementation of automatic replenishment programs will be influenced by the structural and exper iential capabilities available to manage these systems, encompassing both **financial** and human resources. Management commitment of dedicated resources to the programs, however, is also conducive to efficient distribution systems (see Gilliland and Bello, 1997), as is the degree of autonomy and trust that exists to allow successful information exchange between channel partners. Therefore, we see three organizational factors as influential to ARP effectiveness: firm size, centralization of decision making, and commitment to the automatic

replenishment program.

Given this background, Figure 1 is proposed as a conceptual framework for investigating the relationships between these three sets of factors and ARP effectiveness, and in turn the linkage between ARP effectiveness and firm performance, both economic and strategic. In this study, we concentrate on two measures of ARP effectiveness: that of cost effectiveness and service effectiveness. In the following section, specific hypotheses are presented that address these linkages, and where appropriate distinguish between the proposed influences of antecedents on these distinctive ARP outcomes.

RESEARCH HYPOTHESES

Transaction Specific Factors

Standardization

Just as some products require technical adjustments to fit buyer and market needs, individual inventory management systems will also need customization (see Rangan, Menezes, and Maier, 1992). Williamson's (1985) work on transaction cost theory provides a useful foundation for the justification of standardization strategies, whether of products, services, or systems. Both program and process standardization are relevant (Jain, 1989). Program standardization refers to various aspects of the marketing mix and process standardization includes tools that aid in marketing program development and implementation. The latter is seen to include ARPs, because ARPs support the firm's distribution strategies. ARP- related needs will vary across buyers and sellers. Although it may be desirable to standardize ARP systems and thus achieve scale economies, in actuality ARP standardization is seen as a spectrum between complete standardization of the system for all customers served and customized replenishment for each relati onship. The more standardized the ARP system, the greater the benefits of cost reduction will be; however, meeting the individual needs and providing reliable service will be difficult with standardization. Therefore:

(H.sub.1): The greater the standardization of the ARP system, the

a. greater the cost effectiveness of the automatic replenishment program, and

b. lower the service effectiveness of the automatic replenishment program.

Product Cost Volatility

The term "efficiency" is generally associated with cost reduction (Robinson, 1991). Successful cost reduction requires clear understanding and precise definition of all underlying costs including inputs and components, labor, and distribution. The task is usually complicated by the fact that many costs are volatile. Product costs, and therefore prices, are often pre-established, making volatile costs problematic in maintaining margins and revenues. Given that supply-chain members often lock in prices for several months, volatile input and production costs can lead to inaccurate price quotes. This affects both ARP cost effectiveness and service effectiveness, because buyers may be less than satisfied if products arrive at prices that are higher than expected. Therefore:

(H.sub.2): The greater the volatility of product costs, the

a. lower the cost effectiveness of the automatic replenishment program, and

b. lower the service effectiveness of the automatic replenishment program.

Competitive Intensity

According to transaction cost **analysis**, external uncertainty influences contractual arrangements between organizations (Williamson, 1975). External uncertainty often takes the form of market competitiveness, where changing competitive offerings in the marketplace force firms to react to volatile pressures. This sort of uncertainty has been shown to influence firms to internalize transactions and decision making to absorb the volatility of markets (Aulakh and Kotabe, 1997). Studies show that external uncertainty allows negative information

asymmetries to develop and provides the opportunity for outside forces to behave opportunistically (Klein, Frazier, and Roth, 1990). High market competitiveness increases the need for quick decisions, dictating a fluid, and simple information dissemination method (see Engleson, 1995). Responsiveness in highly competitive markets is enhanced with reduced lead-times and predictable order cycles, driving firms to implement and maintain effective ARPs. Rather than being a detri ment to ARP effectiveness, we see competitive intensity as a positive influence of ARP effectiveness, because firms often implement these programs as a result of this uncertainty, rather than despite it. Highly competitive markets would drive firms to differentiate and become more responsive to partner demands. Thus:

(H.sub.3): The greater the competitive intensity of the market, the

a. greater the cost effectiveness of the automatic replenishment program, and

b. greater the service effectiveness of the automatic replenishment program

Strategic Factors

Market-Oriented Strategy

Regarding distribution management, the strategic perspectives of organizations are seen to fundamentally influence outcomes (Dwyer and Oh, 1988). Traditionally, managerial strategic perspectives have been classified as either economically or market oriented; most research has focused on the former (Cavusgil and Zou, 1994). However, firms often seek power positions in the market and block potential movement of competitors through the creation of market imperfections/monopolistic power and barriers to entry (Aulakh and Kotabe, 1997), rather than focusing on short-term economic benefits. The creation of these barriers can take the form of blocked distribution channels or exclusive arrangements with **value**-chain members. Strategic positioning can be enhanced by locking supply-chain partners into ARP agreements thus limiting supplier-switching by retailers or by enhanced relationships via improved inventory replenishment. Such tactics will be viewed as conducive to enhanced market share, customer satisfaction, and a differentiated company image, which are key strategic goals to many firms. Thus:

(H.sub.4): The greater the market orientation of a firm, the

a. lower the cost effectiveness of its automatic replenishment program, and

b. greater the service effectiveness of automatic replenishment program.

Profit-Oriented Strategy

Firms with a profit-oriented strategy are more concerned with bottom-line issues and short-term profitability than market-oriented firms. Economic goals are considered paramount. The profit versus market strategic orientation can be seen as conflicting as well as complementary and subject to hierarchical considerations regarding level of importance (increased market share brings increased profits, yet to increase market share the firm may have to experience losses in the short-term by undercutting competitive price offers) (see Paun and Albaum, 1993). Much of the conflicting nature in strategic perspectives may be attributed to temporal issues. From the supply-chain perspective, short-term strategies are not easily synthesized with long-term objectives. Organizations involved in ARPs are interested in the long-term survival of the firm, which in turn is reliant on the ability of the organization to adapt to a variety of environmental pressures and constraints (see Thach and Axinn, 1991). Preliminary intervie ws with managers indicated that firms often have specific profitability-related strategies. It is posited that these firms will view ARPs as a means by which to reduce costs and increase margins. This orientation will enhance the overall cost effectiveness of the automatic replenishment program.

(H.sub.5): The greater the profitability orientation of a firm, the

a. greater the cost effectiveness of its automatic replenishment

program, and

b. lower the service effectiveness of automatic replenishment program.

Organizational Factors

Firm Size

The effect of firm size and its influence on decisions and outcomes of applied systems has been investigated in a number of inventory management and distribution studies, (e.g., Droge and Germain, 1998). In these studies, the issue of resource commitment to inventory management systems is examined, with a particular focus on the relationships between the degree of **financial** assets, technological assets, and manpower assets consigned to the systems and that system's effectiveness. Although the willingness to commit resources is certainly critical to ARP effectiveness, the ability to do so is equally important (Aulakh and Kotabe, 1997). The ability to commit resources to inventory systems is related to the firm's holdings and human resources. This suggests that firm size will influence ARP effectiveness. Larger firms have the resources required to bear the risks and invest in systems with high fixed costs (Lambkin, 1988; Aulakh and Kotabe, 1997). Thus, the following relationship is posited:

(H.sub.6): The greater the size of the firm, the

a. greater the cost effectiveness of its automatic replenishment program, and

b. greater the service effectiveness of its automatic replenishment program.

Centralization of Decision-Making

Decision-making centralization is defined as the degree to which upper-level management makes firm-related decisions versus those managers closer to the point of sale. Recent studies have argued that a centralized decision making structure within the organization is related to inventory management success (Williams, Magee, and Suzuki, 1998). The political economy framework suggests that the more centralized a decision-making process the more efficient and effective the channel irrespective of transactional form (Stern and Reve, 1980). This perspective is supported at the firm level in past studies (e.g., Myers, 1997), where a more centralized approach to decision making was found to allow managers to integrate cost associated information into strategic moves within the distribution channel. An understanding of underlying costs is most evident at relatively high decision levels. Because centralization of decision making (this in the form of hierarchical information exchange) is a basic tenet of ARPs, program cost effectiveness will be enhanced with this form of managerial decision making. Benefits should be realized in the form of scale economies and the possible cost advantages of increased automated distribution programs (cf. Stern and Reve, 1980). Furthermore, these cost benefits will be shared with the downstream supply-chain partner, enhancing the service performance associated with these relationships. Hierarchical decision-making, however, often comes at the expense of customer satisfaction (Myers, 1997), because lower level managers generally have greater contact time with buyers and are more familiar with their needs. Hence, a centralized approach is seen as detrimental to ARP service effectiveness. Therefore:

(H.sub.7): The more centralized the managerial decision making in the firm, the:

a. greater the cost effectiveness of its automatic replenishment program, and

b. lower the service effectiveness of its automatic replenishment program.

Commitment to Automatic Replenishment Programs

Given that ARPs require substantial **financial** and managerial resources, significant managerial commitment to the program is required for success (Cottrill, 1997). Because ARPs are relatively new within managerial practice with no proven track record (Andel, 1996),

commitment by the firm becomes even more critical to realization of program goals. Furthermore, managerial commitment is important to programs in which information sharing between channel members is a key component. Managerial commitment is seen as the degree to which management dedicates manpower and other resources to its automatic replenishment program, as well as the advanced planning, which takes place within the firm for the system. The more managerial commitment to the program, the better is the ARP' s overall effectiveness in both cost and service.

(H.sub.8): The greater the managerial commitment to the automatic replenishment relationship, the

a. greater the cost effectiveness of its automatic replenishment program, and

b. greater the service effectiveness of its automatic replenishment program.

The ARP Effectiveness-Firm Performance Relationship

Similar to strategic orientation, performance should be viewed in two distinct manners: (1) strategic, where market share, creating barriers to entry, and meeting customer demands serve as performance measures; and (2) economic, which addresses the profit, ROI, and sales volume goals. Performance is defined as the extent to which a firm's economic and strategic objectives are achieved with respect to their activity in the market. As previously discussed, two theoretical foundations underlie the implementation of automatic replenishment programs, that of (1) cost reduction and of (2) service to supply-chain partners. Thus, the investigation of the relationships between these two effectiveness measures and the different types of firm performance is a key point of this study. Such a distinction will provide greater understanding of the outcomes of ARP effectiveness, in that firms that achieve one ARP effectiveness measure may benefit from either (1) economic performance, (2) strategic performance, or both. Firm s achieving ARP cost effectiveness will experience reduced waste and lower expenditures associated with inventory replenishment, which should enhance margins and the overall profitability of the firm. Organizations with high levels of ARP service effectiveness thereby establish more satisfied supply-chain partners and create barriers to competitors by maintaining these relationships. This also positively influences market share and enhances the strategic performance of the firm. Given this, the following hypothesis is offered:

(H.sub.9a): The greater the cost effectiveness of the automatic replenishment program, the greater the economic performance of the firm.

(H.sub.9b): The greater the service effectiveness of the automatic replenishment program, the greater the strategic performance of the firm.

RESEARCH METHODOLOGY

Data Collection

The unit of **analysis** for this study is the individual ARP relationship between buyers and sellers. We investigate two dependent variables: degree of ARP effectiveness and overall performance of the firm. Little empirical data has been published on this topic; therefore; a survey method of data collection was considered appropriate (e.g., Klein et al., 1990). The sampling frame for the data collection included members of the Council of Logistics Management (CLM). CLM members are likely to be involved in the inventory management of the firm.

A survey instrument was developed and pretested with business executives. After modifying the questionnaire to incorporate their suggestions, telephone contact was made to a **random** sampling to screen potential participants regarding involvement in any type of automatic replenishment program. Of the 762 contacts made or attempted, 247 (32.4%) were ineligible because no automatic replenishment program was utilized in their firms. Of the remaining 515 contacts, 24 refused to participate in the survey, 209 did not respond after repeated attempts to contact, and 282 gave permission for mailing the survey. The surveys were then sent to these individuals, with reminder cards being sent two weeks later. A total of 104 surveys were returned; however, 6 had excessive

missing values and were excluded from the **analysis**, resulting in an effective response rate of 33.7%. t tests were used to make comparisons between the 75 manufacturer and 23 retailer respondents. Key constructs were analyzed (such as firm size, centraliz ation of decision making, etc.). No significant differences between manufacturers and retailers were found for the relevant constructs. Thus, the two groups were combined for **analysis** purposes. The manufacturer respondent base was comprised of 50 firms selling directly to retailers and 25 firms selling to other businesses. Again, t tests were used and comparisons of key constructs made to determine whether differences exist between the manufacturer selling directly to retailers and manufacturers selling to other (intermediary) businesses. No significant differences were found between these two groups. Table 1 provides a summary of the descriptive characteristics of the responding firms and managers.

Several concerns regarding survey research methodology warrant investigation before hypothesis testing. These are (1) nonresponse bias that could lead to a systematic exclusion of firms from the population, and (2) common method variance (Podsakoff and Organ, 1986). To test for nonresponse bias, and following the method suggested by Armstrong and Overton (1977), t tests were performed to compare late and early respondents across a number of key variables. These variables included firm size, industry, and age. No significant differences were discovered. The issue of common method variance was addressed in survey design. Also, great care was taken to vary anchors and reverse code where appropriate when utilizing scales within the survey.

Operational Measures

To make central constructs operational within the study, existing scales were utilized wherever possible. When appropriate measures could not be found, scales were developed or adapted to meet the study's requirements. Items were measured on one through seven Likert-type scales except where indicated. Where units of measurement differed across items in the scale, items were standardized. The response format and specific items used for individual variables are described in Appendix I.

Standardization

A simple, one item scale was adopted from Cavusgil and Zou (1994) that directly asked managers to what degree their automatic replenishment programs were standardized or adapted to individual customer-supplier use.

Product Cost Volatility

To measure the volatility of input costs, a three-item scale was developed. Each respondent was asked to assess the fixed, variable, and total cost volatility associated with their products used in ARPs.

Competitive Intensity

Competitive intensity of the market was measured using a four-item scale adapted from John and Weitz (1988). Respondents were asked to evaluate their competitors' aggressiveness, impact on the respondent's decisions, and predictability, as well as the overall competitive intensity of the market.

Market-Oriented Strategy

Following the scale used by Aulakh and Kotabe (1997), managers were asked to evaluate the level of importance placed on two strategic objectives: improving the company's market share position and differentiating the company in the marketplace.

Profit-Oriented Strategy

To measure the firm's profit oriented strategy, respondents were asked to evaluate the level of importance placed on increasing the profitability of the firm and responding to competitive pressures (Porter, 1986).

Firm Size

Two items were utilized to measure firm size, the number of employees in the organization and the total annual sales volume in dollars for the last three years. Items were standardized to create the scale.

Centralization of Decision Making

To make centralization operational, a two-item scale was developed based on Cavusgil and Zou's (1994) measures. Managers were questioned as to the extent of upper-level management's involvement in decision-making, and the extent of decisions made at the division level.

Commitment to Automatic Replenishment Programs

Modifications of several scales from the distribution literature (e.g., Hunt and Morgan, 1994) resulted in a three-item scale, which addressed management's commitment to ARP, the extent of resources committed to ARP, and the extent of thorough advance planning for ARP.

ARP Effectiveness

Two constructs were established for ARP effectiveness to capture the major benefits of these programs, namely cost reductions and improved service.

1. ARP Cost Effectiveness was made operational using a four item scale that addressed the firms' degree of effectiveness in implementing shorter production runs, smaller shipments, delays in final production (postponement), and reduced reliance on forecasts.

2. ARP Service Effectiveness was measured using a four item scale that addressed the degree to which the firm had effectively implemented more frequent deliveries, new communications linkages, more receiver friendly loads, and more predictable order cycles.

Firm Performance

Two measures were used to identify firm performance.

1. Economic Performance was measured using a three item scale addressing overall profitability of the firm, increase/decrease in profits over the last three years, and degree to which profitability goals were met (Bello and Gilliland, 1997).

2. Strategic Performance was adopted from Myers (1999), and consisted of a two-item scale. These included the firm's total increase/decrease in market share over the last three years, and the degree to which strategic goals were met by the firm.

ANALYSES AND RESULTS

Measurement Properties and Psychometric Considerations

To evaluate measurement quality, five steps were taken to determine discriminant validity and composite reliability of the scales. (2) First, measurements were assessed by using a procedure advocated by Gaski and Nevin (1985) whereby a correlation between two scales that is lower than the reliability of each of those scales is taken as proof of good discriminant validity. All scales had reliability estimates in excess of the between-scale correlations. Next, we utilized Anderson's (1987) method to determine that the confidence **interval** (+/- two standard errors) for each pairwise correlation estimate between latent constructs did not include the **value** of one. The scale for each construct met this test.

The third step was to incorporate the method recommended by Fornell and Larcker (1981) to test for discriminant validity. With this method, a construct is deemed empirically distinct if the average variance explained by that construct's items (i.e., that construct's (p.sub.vc((eta)))) is greater than the construct's shared variance with every other construct (the square of the intercorrelation). Thus, Competitive Intensity demonstrates discriminant validity because its average variance extracted ((p.sub.vc((eta))) = .61) is greater than the square of its correlations with Market Oriented Strategy ((-.09.sup.2) = .01), Profit Oriented Strategy, ((.13.sup.2) = .02), Product Cost Volatility ((-0.14.sup.2) = .02), and so forth. All constructs displayed discriminant characteristics in this manner.

Next, an overall confirmatory factor **analysis** was conducted on all items and constructs to examine the adequacy of the construct measures. Each item was restricted to load on its prespecified factor, with the factors themselves being left free to correlate (Gerbing and Anderson, 1988). Elliptical reweighted least squares (ERLS) estimation in EQS provides evidence for model fit (see Sharma, Durvasula, and Dillon,

1989). For each construct and item, the standardized loadings and t-values exceeded the recommended minimums for measurement quality. Examination of the individual item loadings showed that each was large and significant (p (less than) .01), with the exception of one item (fixed costs of our ARP is generally stable) within the cost volatility construct, which measured 0.68. All t values were greater than 3.0. The Bentler-Bonnet normed fit index (NFI) and non-normed fit index (NNFI) and the comparative fit index (CFI) indicate good fit of the confirmatory measurement model (Bentler, 1990) (((chi).sup.2) = 93.7; d. f. = 48; NFI = .97; NNFI = .95; CFI = .95).

These results provide evidence for the convergent validity for each of the measures. Further testing was conducted to ensure that, for each pair of factors, the ((chi).sup.2) **value** for a measurement model that constrains their correlation to equal one is significantly greater than the ((chi).sup.2) **value** for the model that does not place such a constraint. The results of each pairwise construct comparison suggest that the two-factor solution was better than the single factor solution, with all but two differences being significant at the p (less than) .05 level. Both the market oriented strategy-profit oriented strategy and commitment-centralization pairings were significant at the p (less than) .1 level (see Appendix II for these results).

Finally, the results were assessed by examining composite reliability and variance extracted. Following Bagozzi and Yi (1988), two criteria were deemed critical: composite reliability should be greater than .60 and variance extracted should be greater than or equal to .50. As indicated in Table 2, all composite reliabilities were greater than .70. Again using the formula provided by Fornell and Larcker (1981), variance extracted was calculated for each construct. Each scale exhibited an (p.sub.vc((eta))) of (greater than) .50. This indicates that the variance captured by each construct is significantly greater than variance due to measurement error, and further established validity.

RESULTS

The hypothesized model was analyzed using path **analysis**, with the ordinary least squares (OLS) criterion using the disattenuated correlation matrix as input (Loehlin, 1987). This approach was chosen for a number of reasons. First, path **analysis** enables the simultaneous testing of a system of theoretical relationships involving multiple dependent variables. Second, it allows for restricted models with systematic constraints on relationships among variables, testing models that include only those paths that are hypothesized a priori. Finally, the use of path **analysis** enables us to determine model fit based on the assessment of residuals and a ((chi).sup.2) statistic (see Singh and Wilkes, 1996). The estimates of the path coefficients (i.e., the regression beta weights) and the model fit ((chi).sup.2) statistics are presented in Table 3. The model fit (((chi).sup.2) = 40; d. f. = 22; p (greater than) .13) is found to be statistically nonsignificant suggesting that the deviation between the model and observed cor relations is statistically minimal.

Table 3 shows the results of the path **analysis** of Hypotheses 1 through 9. Hypothesis 1 predicts that standardization of automatic replenishment programs will have a positive influence on cost effectiveness, but will be negatively related to service effectiveness. However, the data fall to support these positions (cost effectiveness: (beta) = - .09, p (greater than) .1; service effectiveness: (beta) = .13, p (greater than) .1). It is possible that ARPs are simply not yet standardized enough to realize the economic benefits of cost reduction. The lack of standardization also suggests the degree of customized replenishment may be common.

The relationship between product cost volatility and ARP effectiveness is predicted by Hypothesis 2, which posits a negative relationship between these constructs. The data partially support this hypothesis (cost effectiveness: (beta) = -.28, p (less than) .05; service effectiveness: (beta) = -.01, p (greater than) .1). Volatile product costs

detrimentally affect the firm's ability to provide ARP-related cost effectiveness, making it difficult for managers with dynamic input costs to effectively use ARPs in increasing bottom-line efficiency. Customer service, however, was not affected to a significant degree.

Hypothesis 3 states that competitive market intensity will have a positive influence on ARP effectiveness. The results fail to support this position (cost effectiveness: (beta) = .01; p (greater than) .1; service effectiveness: (beta) = -0.32, p (less than) .05). In fact, the data provide evidence in support of a negative relationship between highly competitive markets and ARP-related customer service. The hyper-competitive state of many modem industries may mitigate the positive effects of ARPs on cost and service effectiveness; the constantly changing and cyclical demand for goods may have made accurate replenishment simply too difficult within some industries for ARPs to maintain their effectiveness for a multitude of products.

Hypothesis 4 relates ARP effectiveness to the firm's strategic orientation. It posits that firms practicing more market-oriented strategies will be characterized by higher service effectiveness and lower cost effectiveness. The data provide significant support (cost effectiveness: (beta) = .32, p (less than) .05; service effectiveness: (beta) = .37, p (less than) .01). When firms can successfully lock channel partners into ARP agreements, their competitors may be forced to seek alternate sources, usually at higher costs. These costs act as competitive disadvantages for the competing firms, and increase the relative **value** of the ARP firm's ability to provide good customer service. Hypothesis 5 posits that a strategic emphasis on profitability has (1) a positive relationship between ARP cost effectiveness and (2) a negative relationship with ARP service effectiveness. However, the data fail to provide even minor support for this relationship (cost effectiveness: (beta) = -.01, p (greater than) .1; service effe ctiveness: (beta) = .17, p (greater than) .1). ARP implementation may become more effective for the firm over the long term, as the programs are more fully integrated into corporate strategic planning.

Hypothesis 6 stated that firm size would positively influence ARP effectiveness. This is partially refuted by the data (cost effectiveness: (beta) = -.24; p (less than) .1; service effectiveness: (beta) = .10; p (greater than) .1). Though larger firms may have the ability to contribute increasing amounts of resources to replenishment programs, decision makers may not yet be fully aware of ARP's contribution to overall profitability, and thus may be unwilling to allocate sufficient assets for them to be effective.

Hypothesis 7 posits that centralization of decision making will have a negative effect on ARP service effectiveness and a positive influence on cost effectiveness. Again, this is partially refuted by the data (cost effectiveness: (beta) = .14, p (less than) .1; service effectiveness: (beta) .25, p (less than) .05). It is evident that a hierarchical approach to decision making does assist in ARPs cost reduction efforts. However, the positive relationship for customer service indicates that ARPs function well from the perspective of the buyer, regardless of the locality of the decision-making processes.

The data strongly support Hypothesis 8, which states that managerial commitment to ARPs is positively related to ARP effectiveness. The results provide solid evidence (cost effectiveness: (beta) = .56, p (less than) .01; service effectiveness: (beta) = .57, p (less than) .01) that managerial commitment leads to both greater perceived cost effectiveness and enhanced customer service. To attain maximum ARP-related success, managers must be willing to allocate optimal amounts of assets to the replenishment programs, even though immediate improvement in performance is unlikely. Furthermore, managers will need to develop an atmosphere of long-term commitment with suppliers and retailers including the release of sensitive firm information, if the ARPs are to be mutually profitable for the firm and trading partners.

Two corollary Hypotheses, H9a and H9b, describe the relationship between ARP effectiveness and firm performance. Hypothesis 9a predicts that high cost effectiveness for the ARP will lead to greater economic performance, whereas Hypothesis 9b posits that high service effectiveness is positively related to greater strategic performance. Although the data provide support for Hypothesis 9b ((beta) = .32, p (less than).05), Hypothesis 9a is not supported ((beta) = .11, p (greater than).1). These findings are critical to our understanding of the **value** of automatic replenishment programs to date. The disparity in performance-related results indicates that achievement of ARP-related strategic goals is not necessarily conducive to a healthier **financial** position for the firm. For example, though a firm might see an increase in market share as a result of ARP implementation, it might do so at greater levels of incurred product cost than before the ARP was put into effect, and thereby would see a lower return on assets as a result.

DISCUSSION AND FUTURE RESEARCH

The current research represents one of the few empirical examinations of automatic replenishment programs to date. Many of the posited relationships were either not supported or results were not as expected; perhaps this is explained by the newness of the programs. With little experience to draw upon, the respondents' firms may not have benefited from a learning curve effect at this time. Also, the nature of programs (highly customized, not appropriate for all types of products, etc.) make it unlikely that the firms would enjoy significant economies of scale.

The findings do, however, have important implications for organizations considering involvement in ARP-type systems. And, for many organizations, involvement will not be optional. Many customers are demanding sales-driven automatic replenishment. Retailers like Burlington Coat Factory are finding that they can "live with less inventory." However, to do so they must be more disciplined about inventory management. Burlington intends to place even more emphasis on automatic replenishment systems in the future (Johnson, 1997).

ARPs represent a radical departure from traditional inventory restocking practices, that is, **historically** as much inventory as possible has been pushed forward within the channel with a primary goal of stocking retail locations in anticipation of customer demand. Traditional push systems are becoming more rare as retailers (and others within the supply chain) resist inventory "loading." Instead, they frequently expect responsive restocking on a customized basis, that is, replenish exactly what was sold at the customer level (adjusted seasonally or due to promotional plans). The Right Start, a catalog and retail company specializing in upscale children's products, relies upon an automatic replenishment system to help them handle retail growth. Stores' expansions have not meant exorbitant increases in inventory thanks to the systems. Instead, the company projects product movement on a store-by-store basis and places orders accordingly based upon three- year sales history and current store-level performance (Au tomatic ID News, 1998).

Managerial commitment is a critical component in the success of the programs. Greater managerial commitment was found to be associated with both cost effectiveness and service effectiveness. The support of management is tantamount when trying to affect change within an organization. Managerial commitment can win others over and help to ensure success--or, at the very least, managerial commitment can dissuade dissention within the ranks or outright sabotage. Higher levels of success are likely either because of management's persuasive capability or by mandate. Thus, it is important that an internal champion (or more than one) be identified early in program development.

These results are preliminary and are necessarily limited by the low levels of involvement in ARPs at the time the survey was conducted. Many firms have indicated interest in and plans to become involved in ARPs.

Thus, further research is warranted to track progress as involvement becomes more widespread and as program efficiencies and effectiveness improve with experience. Areas of interest for future research include examination of ARP performance by industry, the impact of program age/learning curve effect, and relationship dimensions, that is, does closeness of the buyer-seller relationship influence cost and service performance.

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NOTES

(1.) To a large degree the literature that exists concerning supply chain relationships and inventory control focuses on a series of highly investigated constructs such as trust, interdependence, conflict, partner capabilities, and so forth These dyadic level issues have received significant attention and are of obvious importance to the firm. Our interest, however, is in isolating the supplier as an independent entity and concentrating on both the influences and the **value** of ARPs to the manufacturing organization. Although this is only possible to a limited extent, this 'isolated' perspective and investigation outside of the dyadic realm is unique. Furthermore, no ARP would exist without benefit to both supplying and retailing entities, each of which experience internal and external influences independent of their supply chain relationships. Thus, we have purposely limited our investigation of interorganizational phenomena to restrict these influences within the **analysis**.

(2.) This step-wise process closely follows suggested measures of several studies and is applied in recent research such as Grewal, Monroe, and Krishnan (1998).

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Summary Statistics and Characteristics of Respondents

Respondent Breakdown by Industry

Industry	Frequency	Percent
Food and Beverages	30	31.3
Electronics	12	12.2
Chemicals	9	9.2
Apparel	8	8.2
Miscellaneous Manufacturing	6	6.1
Pharmaceuticals	4	4.1
Medical Equipment	4	4.1
Health and Beauty Care	3	3.1
Transportation Equipment	3	3.1
Paper Products	2	2.0
Rubber	2	2.0
Fabricated Metals	2	2.0
Industrial and Commercial Machinery	2	2.0
Other	9	9.2

Respondent Job Titles

Title	Frequency	Percent
Manager (Miscellaneous)	17	17.3
Logistics Manager	15	15.3
Director of Logistics	12	12.2
Vice President Logistics	7	7.1
Distribution Manager	5	5.1
Director (Miscellaneous)	5	5.1
Director of Distribution	4	4.1
Vice President Distribution	3	3.1
Director of Transportation	3	3.1
Distribution Center Manager	3	3.1
Customer Service Manager	2	2.1
Other	11	11.2

Measurement Properties and Confirmatory Factor **Analysis**

	IR	SR	VE
Standardization			.52
Our ARP is standardized for all our customers.			
Product Cost Volatility		.73	.64
Fixed costs of our ARP are generally stable.	.51		
Variable costs (such as labor) of our ARP: are generally stable.	.56		
We can always accurately estimate	.53		

the total costs of our ARP.			
Competitive Intensity		.70	.59
Competitive intensity in our market is relatively low.	.58		
Our major competitors are aggressive	.70		
Actions of our competitors are: easy to predict.	.65		
Our firm changes its marketing practices to keep up with competitors.	.68		
Market-Oriented Strategy		.75	.64
Differentiate our company in the marketplace.	.59		
Improve our company's market share position.	.64		
Profit-Oriented Strategy		.81	.74
Increase the profitability of the company	.77		
Respond to competitive pressure	.74		
Firm Size		.72	.68
Number of full-time employees	.59		
Sales volume in dollars	.63		
Centralization of Decision Making		.78	.63
We have a highly centralized managerial decision making process	.71		
Our division makes few of the important, firm wide managerial decisions	.64		
Commitment to ARPs		.90	.82
The extent of management commitment to ARP	.88		
The extent of resource commitment to ARP	.81		
The extent of thorough advance planning for ARP	.82		
ARP Cost Effectiveness		.75	.60
Shorter production runs	.58		
Smaller shipments	.62		
Delayed final production (postponement)	.64		
Reduced reliance on forecasts	.51		
ARP Service Effectiveness		.76	.58
More frequent deliveries	. 55		
New communications	.60		
Linkages/systems installed	.64		
More receiver friendly loads	.62		
More predictable order cycle	.66		
Economic Performance		.78	.62
The overall profitability of this relationship	.58		
Increase or decrease in profits over the last three years	.60		
Degree to which profitability goals were met	.52		
Strategic Performance		.74	.66
Increase or decrease in market share	.64		
Degree to which strategic goals were met	.61		

For each construct, the item reliability (IR), scale reliability (SR),

and variance extracted (VE) are provided. VE was calculated using the formula provided by Fornell and Larcker (1981).

Summary Assessment of Research Hypotheses

Factor	Hypothesis	Expected Sign	Path Coefficient
ARP Cost Effectiveness			
Standardization	H1a	+	-.09
Product Cost Volatility	H2a	-	-.28 (**)
Competitive Intensity	H3a	+	.01
Market-Oriented Strategy	H4a	-	-.32 (**)
Profit-Oriented Strategy	H5a	+	-.01
Firm Size	H6a	+	-.24 (*)
Centralization	H7a	+	.14
Commitment to ARPs	H8a	+	.56 (**)
ARP Service Effectiveness			
Standardization	H1b	-	.13
Product Cost Volatility	H2b	-	-.01
Competitive Intensity	H3b	+	-.32 (**)
Market-Oriented Strategy	H4b	+	.37 (**)
Profit-Oriented Strategy	H5b	-	.17
Firm Size	H6b	+	.10
Centralization	H7b	-	.25 (**)
Commitment to ARPs	H8b	+	.57 (**)
Economic Performance			
ARP Cost Effectiveness	H9a	+	.11
Strategic Performance			
ARP Service Effectiveness	H9b	+	.32 (**)

Model characteristics: ((chi).sup.2) = 40
d.f. = 22
p = .13.
(*.)p (less than).1
(**.)p (less than) .05.

APPENDIX I

Listing of Research Constructs

Standardization: (scaled 1-7):

Our ARP is: (1) Standardized for all our customers through (7) Adapted to fit the individual needs of our customers

Product Cost Volatility: (scaled 1-7):

Fixed costs of our ARP: (1) are generally stable (7) fluctuate greatly

Variable costs (such as labor) of our ARP: (1) are generally stable (7) fluctuate greatly

We: (1) can always accurately estimate the total costs of our ARP (7) are never really sure what the total costs of our ARP are

Competitive Intensity: (scaled 1-7):

(1) Competitive intensity in our market is relatively low (7) Our market is intensely competitive

Our major competitors are: (1) not particularly aggressive (7) fiercely aggressive

Actions of our competitors are: (1) easy to predict (7) difficult to predict

Our firm changes its marketing practices to keep up with competitors: (1) rarely (1) frequently

Market-Oriented Strategy: What was the importance of the following strategic objectives set by management? (allocated 1-100):

A. Differentiate our company in the marketplace

B. Improve our company's market share position

Profit-Oriented Strategy: What was the importance of the following strategic objectives set by management? (allocated 1-100):

A. Increase the profitability of the company

B. Respond to competitive pressure

Firm Size:

A. Number of full-time employees

B. Sales volume in dollars (last three year average)

Centralization of Decision Making: (scaled 1-7):

We have a highly (1) centralized (7) decentralized managerial decision malting process Our division makes (1) few (7) all of the important, firm wide managerial decisions Commitment to ARPs: (scaled 1 = little - 7 = substantial):

1. The extent of management commitment to ARP
2. The extent of resource commitment to ARP
3. The extent of thorough advance planning for ARP

ARP Effectiveness: How effective has your firm been in implementing these

A. ARP Cost Effectiveness:

1. Shorter production runs
2. Smaller shipments
3. Delayed final production (postponement)
4. Reduced reliance on forecasts

B. ARP Service Effectiveness:

1. More frequent deliveries
2. New communications linkages/systems installed
3. More receiver friendly loads
4. More predictable order cycle

Performance:

A. Economic Performance:

Rate the overall profitability of this relationship (1 = highly unprofitable-7 = highly profitable)

Increase or decrease in profits over the last three years (expressed as a percentage) egree to which profitability goals were met (expressed as a percentage)

B. Strategic Performance:

Increase or decrease in market share over the last three years (expressed as a percentage)

Degree to which strategic goals were met (expressed as a percentage)

APPENDIX II

One-Factor Versus Two-Factor Confirmatory Model Comparison Discriminant Validity **Analysis**

Variable	1	2	3	4	5	6	7	8
1. Firm Size	--							
2. Centralization of	.10	--						
Decision Making	77.41							
	26.84							
3. Commitment to	.07	.14	--					
ARPs	132.32	122.32						
	30.04	18.43						
4. Standardization	.06	.12	.07	--				
	41.35	104.46	88.43					
	11.45	44.8	11.10					
5. Product Cost	.11	.15	-.17	.14	--			
Volatility	154.76	151.32	203.42	48.56				
	43.25	29.98	19.04	11.98				
6. Competitive	.06	-.08	.11	.12	.14	--		
Intensity	88.92	69.74	205.59	68.48	101.34			
	25.20	18.42	62.65	21.26	26.47			
7. Market-Oriented	.11	.14	.17	.10	-.11	-.09	--	
strategy	101.32	111.14	145.32	98.44	143.54	110.34		
	41.34	36.01	38.91	39.42	33.56	26.83		
8. Profit-Oriented	-.08	.13	.04	-.08	.01	-.13	.16	--
strategy	99.93	156.00	132.48	93.56	121.48	121.93	57.45	
	11.87	48.43	13.05	9.45	23.98	16.49	21.33	

9. ARP Cost	.17	.17	.50	.21	-.17	.18	-.01	-.02
Effectiveness	134.53	78.92	100.45	84.03	56.76	98.57	95.39	105.21
	30.77	23.44	18.42	30.45	9.45	12.48	18.74	14.65
10. ARP Service	.02	.28	.41	.12	.11	.21	.16	.18
Effectiveness	88.43	145.33	99.46	79.62	83.26	156.92	80.23	100.61
	25.32	42.87	30.34	8.55	26.07	31.08	8.36	28.31
11. Economic	.15	.09	.19	.11	-.15	-.09	.14	.19
Performance	93.16	151.70	108.43	90.04	108.45	100.44	91.24	99.24
	31.20	48.32	16.55	14.66	17.20	12.67	20.06	15.66
12. Strategic	.09	.13	.13	.07	-.08	-.19	.09	.08
Performance	77.87	100.32	95.49	56.94	113.29	140.32	68.34	84.31
	19.43	15.54	17.04	10.23	21.48	32.85	9.25	9.23

Variable	9	10	11	12
1. Firm Size				
2. Centralization of Decision Making				
3. Commitment to ARPs				
4. Standardization				
5. Product Cost Volatility				
6. Competitive Intensity				
7. Market-Oriented strategy				
8. Profit-Oriented strategy				
9. ARP Cost Effectiveness	--			
10. ARP Service	.41	--		
Effectiveness	131.51			
	12.59			
11. Economic	.17	.11	--	
Performance	18.24	88.24		
	11.65	14.33		
12. Strategic	.18	.23	.21	--
Performance	95.38	69.58	99.54	
	21.33	7.84	21.64	

The first number is the correlation between the latent constructs. The second number is the difference between chi-square: ((chi).sup.2) for the one-factor model - ((chi).sup.2) for the two-factor model (all the differences were significant at the .05 level, with the exception of market oriented strategy-profit oriented strategy and commitment-centralization which were significant at the .1 level). The third number is the ((chi).sup.2) for the two-factor model.

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Publisher Name: Elsevier Science Publishers Ltd.
Event Names: *389 (Alliances, partnerships)
Geographic Names: *1USA (United States)
Product Names: *5200000 (Retail Trade)
Industry Names: BUSN (Any type of business); RETL (Retailing)
Special Features: INDUSTRY
Advertising Codes: 59 Channels of Distribution

30/9/2 (Item 2 from file: 148)
12998862 **Supplier Number:** 68536042 (THIS IS THE FULL TEXT)

CALCULATING THE EXPECTATION AND VARIANCE OF THE PRESENT **VALUE** FOR A **RANDOM** PROFIT STREAM OF UNCERTAIN DURATION.(Statistical Data Included)

GERCHAK, YIGAL; ASTEBRO, THOMAS

Engineering Economist , 45 , 4 , 339
Winter , 2000
Document Type: Statistical Data Included
ISSN: 0013-791X
Language: English
Record Type: Fulltext
Word Count: 2667 **Line Count:** 00252

Text:

ABSTRACT

We derive the mean and variance of the **random** discounted sum (((sigma).sup.N).sub.n=1) ((theta).sup.n)(X.sub.n), when N is uncertain, as are the (X.sub.n)'s. This quantity arises in applications involving **random** cash-flows over an uncertain number of years. One such application is R&D projects, where both the magnitude and duration of cash-flows are uncertain at the time of investment decision. Previous models have assumed cash-flow duration to be certain. We relax this assumption. We then specialize these results to geometric, mixed-geometric and Poisson distributions of the cash-flow duration.

INTRODUCTION

Suppose that (X.sub.1), (X.sub.2), are future annual uncertain profits or costs associated with some venture, that will last for a **random** number of years N. Then, if (theta) is the discount rate,

(((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n) (1)

is the (**random**) present **value** of these profits. When (theta) = 1, (1) reduces to the ordinary **Random** Sum, studied in many textbooks (e.g., (6)). We shall thus refer to (1) as the **Random** Discounted Sum (RDS). Our goal is to obtain the first two moments of (1). The mean is of interest in its own right (Astebro and Gerchak, (1)), and, jointly with the variance, can be used to compute approximate probabilities using Chebychev's Inequality or the Central Limit Theorem (e.g., (5)).

While one could clearly simulate the RDS ((2), and references there), a closed form expression for the RDS's moments is useful in many

engineering economics problems (3). It enables one to see the effects of changing parameters of the underlying distributions on the RDS's moments immediately. As shall be seen, it is also easily implementable in spreadsheet applications, a clearly useful feature. We illustrate the application of several alternative closed form expressions for the RDS in the case of Research and Development (R&D) projects. With R&D projects both the magnitude and duration of the profit stream are typically unknown at the time when an investment decision needs to be undertaken.

Our calculation of RDS's variance (but not that of the mean) makes the restrictive assumption that cash-flows are uncorrelated over time (for treatments of correlations see (5), and references therein as well as (3)). But we allow the duration of cash-flow to be **random**, which previous Net Present **Value** (NPV) literature does not. This relaxation provides for more realistic application of closed-form solutions of the RDS than before.

DERIVATION OF MEAN FOR RDS

It is well-known that when the (X.sub.n)'s have equal means, are independent of N, and E(N) (less than) (infinity), then E((((sigma).sup.N).sub.n=1) (X.sub.n)) = E(N)E(X). We now extend this result to the RDS.

PROPOSITION: 1

If (X.sub.1), (X.sub.2), ... have equal means, (micro), and are independent of N, and E(N) (less than) (infinity), then

E((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = (theta)(micro)/1 - (theta) (1 - E(((theta).sup.N))). (2)

PROOF:

Since the (X.sub.n)'s are independent of N,

E((((sigma).sup.N).sub.i=1) ((theta).sup.i) (X.sub.i)\N = n) = E((((sigma).sup.n).sub.i=1) ((theta).sup.i) (X.sub.i)) = (((sigma).sup.n).sub.i=1) ((theta).sup.i) E((X.sub.i)) = (micro)(theta)(1 - ((theta).sup.n))/1 - (theta),

where the last equality is simply the sum of a geometric series. Thus, denoting an expectation with respect to N by (E.sub.N),

E((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = (E.sub.N)\(((theta).sub.(micro))(1 - ((theta).sup.N))/1 - (theta)) = ((theta).sub.(micro))/1 - (theta) (1 - E(((theta).sup.N))).

Note that this result does not require that the (X.sub.i)'s will be independent of each other.

Note that (2) generalizes to geometrically increasing/decreasing means, which may be more realistic in business applications. That is, if E((X.sub.n)) = ((alpha).sup.n)E((X.sub.1)), then

E((((sigma).sup.N).sub.n=1) ((theta).sup.n)(X.sub.n)) = ((theta)(alpha)E((X.sub.1))/1 - (theta)(alpha) {1 - E((((theta)(alpha)).sup.N))} (3)

It is evident from (2) that the key quantity needed to evaluate E((((sigma).sup.N).sub.n=1) ((theta).sup.n)(X.sub.n)) is thus E(((theta).sup.N)), the probability generating function of N. We now state the resulting **value** for three plausible distributions of N and compute the mean for two of the three distributions using data on R&D projects. These examples will illustrate the usefulness and simplicity of using a closed-form solution to compute NPV under more realistic assumptions than before.

APPLICATION TO R&D INVESTMENT **ANALYSIS**

We surveyed a **random** sample of 1,826 inventors that submitted an idea or invention for review to the Inventor's Assistance Program (IAP) at the Canadian Innovation Center (CIC) in Waterloo, Canada, and obtained 1,095 usable responses (75% of the sample). The sample frame consisted of all 8,797 records of submissions to the IAP during the period 1976-1993. We sampled equal proportions from each year.

We collected survey data on cash-flow from inventors of inventions that successfully reached the marketplace at some time between 1976-1993 and that were still selling in 1995 (52 observations). With these data we

estimated average yearly cash-flow to be $48,218 with a standard deviation of $137,505. (Data are in Canadian dollars.)

We obtained data on the survival time for 104 successful inventions of which 49 had discontinued sales by 1995 and 55 were right censored by the end of 1995. See (1) for details.

FIGURE 1 depicts the distribution of survival times when one assumes that the censored observation fails in the year in which it is censored. The real survival time for the censored observation should, however, be longer. The figure suggests that the geometric distribution might fit the data reasonably well.

FIGURE 2 shows the frequency for censored and non-censored observations with the year of submission to the IAP (the approximate starting time for the spell.) It indicates that percentages of censored observations are all lower than that for non-censored observations before the 15th year except for the 12th year. After and including the 15th year, however, the percentages for censored observations are all much higher than that for non-censored observations within the same year. In other words, the later the start of the spell the more likely that it is censored. It is therefore important to use an analytical procedure to correct for right censoring when computing the expected survival time.

Using the exponential model in the LIFEREG procedure in SAS and correcting for right censoring, we obtain that the expected survival time for our data is 10.97 years. A log-likelihood ratio test rejected the hypothesis that the Weibull distribution fits the data better than the exponential

(((chi).sup.2) = 0.0182, p (greater than) 0.10).

To complete the determination of E((((sigma).sup.N).sub.n=1) ((theta).sup.n) ((X.sub.n)) one needs an estimate of the opportunity cost (theta) = 1/(1 + r). **Value** (r.sub.j) should reflect the opportunity cost of capital in project j, and is commonly defined as (r.sub.j) = (r.sub.f) + ((beta).sub.j)((r.sub.m) - (r.sub.f)), where (r.sub.f) is the risk-free rate, (r.sub.m) is the market rate of return of an alternative investment and ((beta).sub.j) = cov((r.sub.j),(r.sub.m))/ (((sigma).sup.2).sub.m) (7). The appropriate time horizon for the risk-free rate is equivalent to the expected time horizon for the invention, which is about ten years. Because the return on ten year government bonds is slightly lower than for five-year government bonds we use the average return on intermediate-term government bonds as the risk-free rate instead: 4.9% (4). Picking an appropriate vlaue for (r.sub.m) is difficult because there is little data on the market for inventions. However, it is fair to claim that inventive activities are very risky. We therefore seek data on the return to an alternative investment that is very risky. The ninth and tenth firm size deciles of stocks traded on the NYSE reflect high stock market risks with an average return of 17.7% over the years 1926 to 1987 ((4), p. 72). Ibbotson and Sinquefield furthermore report a beta of -0.07 betwe en these small capitalized stocks and intermediate-term government bonds (p. 95) resulting in an estimate of r = 5.8%.

While we used an estimation procedure that assumed data was continuous, they are in fact discrete, and the appropriate function to describe the distribution is the geometric.

EXAMPLES OF CALCULATING THE MEAN

EXAMPLE I

N (sim) geometric (p). That is,

P(N = n) = ((1 - p).sup.n-1) p, n=1,2,...

This model characterizes constant failure/termination rate in discrete time. Then (e.g., Ross, p.16)

E(((theta).sup.N)) = (P.sup.(theta))/1-((1 - p).sup.(theta))'

so

E((((sigma).sup.N).sub.n=1)((theta).sup.n)(X.sub.n)) = ((theta).sub.(micro))/1-(theta) (1 - (p.sup.(theta))/1 - ((1 - p).sup.(theta))) = ((theta).sub.(micro))/1 - ((1 - p).sup.(theta)).

Since for the geometric E(N) = 1/p, then using our estimated mean

duration of 10.97, p (approximate) 1/11 and with (theta) (approximate) 0.945 and (micro) = $48,218, we get

E((((sigma).sup.N).sub.n=1) ((theta).sup.n)(X.sub.n)) = 0.945x48,218/1 - (1 - 0.09)0.945 = $323,808.

This calculation was made in (1) for actual data from the Innovation Center. Compared with other mean RDS figures it was then used to estimate the **value** of the advice given.

EXAMPLE 2

N (sim) uniform mixture of geometric distributions. Here

P(N = n) = ((integral).sup.1).sub.0)((1-P).sup.n-1) pdp = 1/n(n + 1)

Mixtures of geometric distributions capture decreasing failure/termination rate, which corresponds to innovations where the longer they succeeded, the longer yet they are likely to succeed.

Thus

E(((theta).sup.N)) = (((sigma).sup.(infinity)).sub.n=1)((theta).sup.n)/n(n + 1),

which can be shown to equal 1 + ((1 - (theta))ln(1 - (theta)))/(theta). Thus

E((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = ((theta).sub.(micro))/1-(theta) (1 - E(((theta).sup.n))) = (micro)ln(1/1-(theta)).

With the same data as before for (micro) and (theta) we get

E((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = 48,218ln(1/1 - 0.945) = $140,010.

EXAMPLE 3

N (sim) Poisson ((lambda)). The Poisson might be the most familiar distribution of a nonnegative integer-valued quantity.

Here E(((theta).sup.N)) = (e.sup.(lambda)((theta)-1)).

Thus

E((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = (theta)(micro)/1 - (theta) (1 - (e.sup.(lambda)((theta)-1))).

The Poisson was not used in (1), but it could be an attractive model for duration data with mode not necessarily located at zero.

DERIVATION OF VARIANCE FOR RDS

When the (X.sub.n)'s are uncorrelated, have equal means and variances and are independent of N it is known that

Var((((sigma).sup.N).sub.n=1) (X.sub.n)) = E(N)Var(X) + ((micro).sup.2) Var(N).

For the RDS, we have

PROPOSITION 2

If the (X.sub.n)'s are uncorrelated, have equal means and variances and are independent of N then

Var((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = ((theta).sup.2)Var(X)/1 - ((theta).sup.2)(1 - E(((theta).sup.2N))) + ((theta). sup.2)((micro).sup.2)/((1 - (theta)).sup.2)Var(((theta).sup.N)). (4)

PROOF:

Since the (X.sub.i)'s are uncorrelated, independent of N and have equal means and variances

E((((((sigma).sup.N).sub.n=1)((theta).sup.i)(X.sub.i)).sup.2) \ N = n) = Var((((sigma).sup.n).sub.i=1)((theta).sup.i)(X.sub.i)) + ((E((((sigma).sup.n).sub.i=1)((theta).sup.i)(X.sub.i))).sup.2)

= Var(X)(((sigma).sup.n).sub.i=1)((((theta).sup.i)).sup.2) + (((theta)(micro)/1 - (theta)(1 - ((theta).sup.n))).sup.2)

= ((theta).sup.2)(1 - ((theta).sup.2n))Var(X)/1 - ((theta).sup.2) + ((theta).sup.2)((micro).sup.2)/((1 - (theta)).sup.2)((1 - ((theta).sup.n)).sup.2). (5)

Thus

E((((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)).sup.2)) = ((theta).sup.2)Var(X)/1 - ((theta).sup.2)(1 - E(((theta).sup.2N))) + ((theta).sup.2)((micro).sup.2)/((1 - (theta)).sup.2)E(((1 - ((theta).sup.N)).sup.2)).

Subtracting the square of E((((sigma).sup.N).sub.n=1)((theta).sup.n)(X.sub.n)), we obtain the required result.

Now, if the (X.sub.n)'s are positively correlated, the above will constitute a lower bound on the variance of RDS. Kim, et al. (and references therein) provide generalizations of(5) to correlated profits (for fixed n).

Again, Proposition 2 generalizes to geometrically increasing/decreasing means and/or variances. Thus, if

E((X.sub.n)) = ((alpha).sup.n)E((X.sub.1)) and Var((X.sub.n)) = ((beta).sup.n)Var((X.sub.1)), then

Var((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = (((beta)(theta)).sup.2)Var((X.sub.1))/1 - (((beta)(theta)).sup.2) (1 - E((((beta)(theta)).sup.2N))) + (((alpha)(theta)).sup.2) ((E((X.sub.1))).sup.2)/((1 - (alpha)(theta)).sup.2) Var((((alpha)(theta)).sup.N)).

We now evaluate E(((theta).sup.2N), Var(((theta).sup.N)) and Var((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) for the parametric distributions of N used before.

EXAMPLES OF CALCULATING THE VARIANCE

EXAMPLE 1 (REVISED)

For a geometric N,

E(((theta).sup.2N)) = p((theta).sup.2) /(1 -(1 - p)((theta).sup.2)),

Var(((theta).sup.N)) = p((theta).sup.2) /(1 -(1 - p)((theta).sup.2) - (p.sup.2)((theta).sup.2)/(1 -(1 - p)((theta).sup.2)

=p(1 - p)((theta).sup.2) ((1 - (theta)).sup.2) /(1 -(1 - p)((theta).sup.2))(1 -(1 - p)((theta).sup.2))

Thus

Var((((sigma).sup.N).sub.n=1)((theta).sup.n)(X.sub.n)) = ((theta).sup.2)/1 - ((theta).sup.2)(1 - p) (Var(X) + p(1 - p)((theta).sup.2)((micro).sup.2)/((1 - (theta)(1 - p)).sup.2)).

With Var(X) = 18.91 x (10.sup.9) and (theta), (micro) and p as before we obtain Var((((sigma).sup.N).sub.n=1) ((theta).sup.n) (X.sub.n)) = 1.31 x (10.sup.11). In conjunction with the mean ($323,808) the variance provides a confidence **interval** for the RDS.

EXAMPLE 2 (REVISITED)

For a uniform mixture of geometrics,

E(((theta).sup.2N)) = (((sigma).sup.(infinity).sub.n=1) ((theta).sup.2n) / n(n + 1) = 1 + ((1 - ((theta).sup.2))ln(1 - ((theta).sup.2))/((theta).sup.2).

Thus

Var(((theta).sup.N)) = {(1-((theta).sup.2))ln(1+(theta))+(1-3((theta).sup.2)+2((theta).sup.3))ln(1-(theta))-((1-(theta)).sup.2)(ln((1-(theta)).sup.2))}/((theta).sup.2)

The variance of the RDS can now be obtained from Proposition 2. With the same data as above we get Var((((sigma).sup.N).sub.ln=1) ((theta).sup.n) (X.sub.n)) = 9.06 x (10.sup.22)

EXAMPLE 3 (REVISITED)

If N is Poisson, then E(((theta).sup.2N)) = (e.sup.(lambda)(((theta).sup.2)-1)),

so Var (((theta).sup.N) = (e.sup.(lambda)(((theta).sup.2)-1)) - (e.sup.2(lambda)((theta)-1)) = (((e.sup.(lambda)((theta)-1))).sup.(theta)+1) - (((e.sup.(lambda)((theta)-1))).sup.2). The variance of the RDS can be obtained by using Proposition 2.

CONCLUSIONS

Our goal was to extend to **Random** Discounted Sums the derivation of moments commonly given for Ordinary **Random** Sums. Much of the NPV calculations in the engineering economics literature actually assume a fixed/known cash-flow duration. Our generalization to a **random** duration came at a high price, though: In calculating the

variance, we assumed that annual cash-flows are uncorrelated. But, the calculation of mean RDS, which is sometimes all that one needs (e.g. (1)) does not require this assumption, and thus provides generality.

As we illustrated with data, the cash-flow duration can often be captured by a geometric distribution. We have shown that for such distributions the RDS's moments are particularly simple. This version of the model has significant potential for applications, for example when making decisions about investments in R&D projects.

It is plausible that in some applications, large/small cash flows may be associated with long/short durations of cash flows. Thus the (X.sub.r)'s will not be independent of N. But the assumed independence of the duration from the magnitudes of cash flow can be weakened to N being merely a "stopping time" for (X.sub.1) (X.sub.2), ... (Wald's Equation; see (6)). Proposition 1 still holds in such a scenario.

ACKNOWLEDGEMENT

This work was supported by the Natural Sciences and Engineering Research Council of Canada. We wish to thank the Area Editor and the referees for useful comments and references.

BIOGRAPHICAL SKETCHES

THOMAS ASTEBRO is the University of Waterloo's Associate Chair of Management of Technological Change, funded by the Natural Sciences and Engineering and the Social Sciences and Humanities Research Councils of Canada, with industrial sponsorship from the Canadian Imperial Bank of Commerce. Dr. Astebro conducts research in the economics of technological change and entrepreneurship. He has recently published in IEEE Transactions of Engineering Management and The Engineering Economist. He is frequently invited to give speeches on the subject of assessing entrepreneurial ventures.

YIGAL GERCHAK is a professor at the Department of Management Sciences, University of Waterloo, and the Department of Industrial Engineering, Tel-Aviv University. Current research interests include operations management in production and service organizations, coordination in decentralized supply chains, and the economics of uncertainty. He has published near 80 articles in leading journals in OM, OR, and IE and related disciplines. Dr. Gerchak is currently serving on the editorial boards of LIE Transactions and the M & SOM Journal.

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Industry Codes/Names: BUSN Any type of business; OIL Petroleum, Energy Resources and Mining
Descriptors: Profit--Models; Corporate profits--Models; **Random** variables-- Models; Business enterprises--**Finance**
Geographic Codes: 1USA United States
File Segment: TI File 148

30/9/3 (Item 3 from file: 15)
02131265 68951043
To your heart's content: A model of affective diversity in top management teams

Barsade, Sigal G; Ward, Andrew J; Turner, Jean D F; Sonnenfeld, Jeffrey A
Administrative Science Quarterly v45n4 pp: 802-836
Dec 2000
CODEN: ASCQAG
ISSN: 0001-8392 Journal Code: ASQ
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 35 Pages
Special Feature: Chart Formula Table Graph
Word Count: 16296

Abstract:

In this study a model of how diversity in positive affect (PA) among group members influences individual attitudes, group processes, and group performance is developed. The model is tested on a sample of 62 US top management teams. Greater affective fit between a team member and his or her group is related to more positive attitudes about group relations and perceptions of greater influence within the group. Results also suggest there is a negative relationship between a team's diversity in trait positive affect and both the chief executive officers' use of participatory decision making and **financial** performance. Exploratory analyses reveal that affectively diverse, low mean trait PA groups experienced the greatest task and emotional conflict and the least cooperation. Analyses of diversity in trait negative affect produced no significant results. The implications of the study for the group emotion, team composition, group performance, and top management team literatures are discussed.

Text:

In this study we develop a model of how diversity in positive affect (PA) among group members influences individual attitudes, group processes, and group performance. We test the model on a sample of 62 U.S. top management teams. Greater affective fit between a team member and his or her group is related to more positive attitudes about group relations and perceptions of greater influence within the group. Results also suggest there is a negative relationship between a team's diversity in trait positive affect and both the chief executive officers' use of participatory decision making and **financial** performance. Exploratory analyses reveal that affectively diverse, low mean trait PA groups experienced the greatest task and emotional conflict and the least cooperation. Analyses of diversity in trait negative affect produced no significant results. We discuss the implications of our study for the group emotion, team composition, group performance, and top management team literatures The study of the costs and benefits of diversity in the workplace has been going on at a vigorous pace

over the last two decades or more. This research has led to many theoretical and practical insights into the effects of diversity on organizational life (Jackson, 1991; Milliken and Martins, 1996). Rich as this research has been, its focus has been mainly on constantly observable forms of difference, primarily race and gender, with explanations for the crux of the difference based on cognitive factors such as perceived differences in attitudes or values. While these demographic and cognitive differences are certainly important, another type of diversity, based on potentially powerful psychological personality factors, also influences organizational functioning. This is trait positive affective diversity, or individual differences in positive affective personality-the degree to which a person is cheerful and energetic (high positive affect) versus subdued and reserved (low positive affect).

Employee affect has become an area of increasing focus in its own right in organization studies (for a review, see Isen and Baron, 1991; Weiss and Cropanzano, 1996). This interest has included a joint inquiry into employee affect and group dynamics (e.g., Smith and Crandell, 1984), a pairing that has been implicit in studies of group morale as "group spirit" (Muchinsky, 1983: 304), organizational climate defined as group affective tone (see Schneider and Reichers, 1983, for a review), and in the emphasis on the affective bonds between group members in the literature on groups and cohesiveness (Ashforth and Humphrey, 1995). **Historically**, what has been missing from much of this research is a systematic examination of how affect, clearly defined and carefully operationalized, influences individual and group processes and outcomes. Studies that have carefully measured and defined affect have now begun to demonstrate more explicitly the influence of group affect on individual and group-level behavior. Looking at the mean level of group affect, George (1990, 1995) found that positive affective work-group tone was associated with decreased absenteeism and better customer service. The emphasis on mean level of affect in the field is particularly relevant when groups are homogenous. As with other group composition variables, however, groups can vary widely in their affective distribution, and thus, groups' diversity in positive affect can help us explain and understand other sources of work teams' feelings, attitudes, and behaviors. To date, a team's composition has been primarily studied through demographic variables such as age, gender, and race, or through organization-related characteristics such as tenure or functional background. These characteristics are used as operationalizations, or proxies, for deeper, generally cognitive or **value**-based differences between individuals, but they are based on cognitive, not affective, similarity-attraction arguments. Our study adds an affective and personality-- based focus to this line of research, which has the potential to shed new light on the influence of team composition on group life by focusing on a group's diversity in positive affect.

POSITIVE AFFECTIVE DIVERSITY IN GROUPS

In considering affective diversity and its consequences, it is important to be clear about what type of affect is being studied. We focus here on a person's trait of positive affect (PA), which is his or her stable underlying affective personality (Staw, Bell, and Clausen, 1986; Watson, Clark, and Tellegen, 1988) and leads to relative consistency in affective reactions over time (Lazarus, 1991; Watson and Walker, 1996). Trait affect does not need a specific target; it is a generalized tendency toward having a particular level of positive and negative moods, which then permeate all of an individual's experiences (Lazarus, 1991). Extensive work by psychologists studying affect has focused on the trait of positive affect, the degree to which a person is high in enthusiasm, energy, mental alertness, and determination (Watson and Tellegen, 1985; Watson, Clark, and Tellegen, 1988), and on the trait of negative affect, the degree to which one feels subjective distress, such as irritability, anxiety, or

nervousness (Watson and Clark, 1984). In our study, we focus on positive rather than negative trait affect. Although, semantically, positive and negative trait affect sound as if they are two sides of a bipolar scale, they are each in fact unipolar constructs that have been shown to be largely independent over time (e.g., Diener and Emmons, 1985; Goldstein and Strube, 1994), to operate according to different processes (e.g., Heller, 1990; Fredrickson, 1998), and to relate to different types of predictor and outcome variables (e.g., Watson et al., 1992). Researchers who have examined differences between the two constructs have found a significantly stronger link between trait positive affect and the social processes inherent in the group settings we examine.'

We chose to model the effects of trait positive affect because it is dispositional and therefore lies directly within the realm of "basic attributes" that Pfeffer (1983: 303) discussed in his classic description of the compositional effects of groups. Also, trait affect has already been shown to influence many aspects of organizational life, ranging from consistency in job attitudes and satisfaction to work performance (e.g., Staw, Bell, and Clausen, 1986; Brief et al., 1988; Cropanzano, James, and Konovsky, 1993). Although there has not been as much work examining the influence of trait affect on a group level, there is mounting evidence that it can be a useful explanatory construct in understanding workplace behavior (e.g., George, 1990, 1995).

Research has shown trait positive and negative affect to be classic personality factors, congruent with extraversion and neuroticism (John, 1990: 86), a result repeatedly demonstrated in the literature (see Parkinson et al., 1996: 61; reviews by Larsen and Diener, 1992; Meyer and Shack, 1989). We chose to focus on trait affect, however, rather than other personality variables, as trait affect is a more narrowly affectively defined construct, which leads to specifically affective manifestations (Tellegen, 1985; Watson and Clark, 1992; Parkinson et al., 1996: 61). This is by contrast, for example, to extroversion, which in addition to affective components such as cold and warm includes many other, less purely affectively related components, such as degree of sociability, talkativeness, spontaneity, and being a joiner versus being a loner (Costa and McCrae, 1992). Trait positive affect appears to be the best candidate for an initial study of how affective diversity relates to the interaction and performance of top management teams. While there is not as much prior research supporting a negative affective diversity model, we feel it is too soon to rule out negative affect in this context and thus conduct exploratory trait negative affectivity tests for all of our hypotheses as well.

Group Composition Analyses of the effects of group composition have been used to explain a wide variety of group phenomena, such as turnover, interpersonal relations, innovation, and performance, in general work groups (for reviews, see Jackson, 1995; Williams and O'Reilly, 1999) and in top management teams (see Finkelstein and Hambrick, 1996). Here, we focus on the group's diversity in trait positive affect. As with other group composition variables, when a group is interacting, members should react to each other's trait positive affect. Although trait positive affect is not a demographic characteristic, it is still readily identifiable, perhaps more so than the underlying values demographic characteristics are meant to represent. Research by Ekman and colleagues (1982) has shown that internal emotional states are reliably observable and can "leak" even when people are trying to hide them (Ekman, 1992). Supporting this, strong correlations have been found between peers' ratings of trait positive affect and selfreport ratings of trait positive affect, as well as among the peer raters themselves (Barsade, 1995), indicating the observability and reliability of trait positive affect.

Trait emotion can also influence group functioning through its effect on mood, or state affect. State and trait affect are so closely related that they have been described as the "former being provoked in a specific context, the latter (background) influencing this provocation" (Lazarus, 1991: 47). While state affect is a shorter-term reaction with greater fluctuation than trait affect (Tellegen, 1985), researchers have viewed their underlying processes as being very similar (see Allen and Potkay, 1981; Ekman and Davidson, 1994: 49-96), with trait affect at the personality level strongly helping to determine state affect (Lazarus, 1991: 47). Thus, a combination of individuals' mood states will reflect their overall trait affect, and other individuals with whom a given individual interacts regularly will perceive and characterize the person by his or her underlying trait affect moderated by short-term mood states. Because trait affect can be perceived, it is likely to be the basis for similarity-attraction effects similar to the cognitive similarity-attraction effects discussed by researchers studying diversity with demographics and underlying cognitive or **value**-related variables.

Affective Similarity-Attraction Affective diversity is a result of the cumulative affective fit or misfit among group members. This fit is important because, as with other **value** or demographic differences, people care about how similar they are to others on a variety of dimensions. The finding that people consciously and unconsciously prefer others who are similar to them is one of the most robust and reliable social psychological findings (see Berscheid, 1985, for a review). This phenomenon has also been strongly supported in the small group and organizational context (see Williams and O'Reilly, 1999, for a review), and in sociological research on homophily, defined as "the tendency for persons who affiliate with each other to be similar on various attributes" (Hogue and Steinberg, 1995: 897). The general finding in these literatures is that people prefer to interact with other individuals or groups who have (or are perceived to have) attitudes and values similar to their own (e.g., Byrne, 1971; Berscheid, 1985; Schneider, 1987; McPherson and Smith-Lovin, 1987). While the research in similarity-attraction has not traditionally sought a source of affective similarity and difference, there is evidence that these processes operate similarly and that emotions can be a fruitful area in which to examine similarity-attraction effects (Berscheid, 1985: 424).

A theoretical base for the similarity-attraction effect is the concept of reinforcement and the reinforcing **value** of similar attitudes or values (see McGuire, 1985, for a review). While reinforcement effects have classically been studied with regard to cognition, much of the logic behind this research in attraction (e.g., Newcomb, 1961; Byrne, 1971; Lott and Lott, 1985) can be applied to emotions as well. Although they studied cognition, not affect, Clore and Byrne's (1974) description of the similarity-attraction process helps our understanding of how reciprocal reinforcement could also occur affectively. Clore and Byrne's cognitive argument can be summarized as follows: "I think the same way you do, which I find reinforcing, which makes me feel good, which then makes me attracted to you, which is then reciprocated by you." As affect can be a type of reinforcer in its own right (Lott and Lott, 1974), their argument could be modified to describe similarity-attraction in terms of positive affect. Imagine a situation in which an employee who has high trait positive affect (cheerful and energetic) meets another employee who is also this way. The reciprocal emotional information would be conveyed as follows: "I feel the same way you do (i.e., upbeat and energetic), which I find reinforcing, which makes me feel good, which then makes me attracted to you, which is then reciprocated by you." In this way, positive affect can serve as information, affective similarity confirms the appropriateness of emotions, and this reinforcement then leads to attraction. The reinforcing properties should occur for people at all levels of positive affect. Thus, one can

also imagine a situation in which a subdued and reserved (low positive affect) employee interacts with the cheerful and energetic (high positive affect) employee described above: "I do not feel the same way you do, so I do not feel your emotional response is reinforcing, which makes me feel bad, which does not lead me to be attracted to you, and this lack of attraction is then reciprocated by you."
Another rationale for the cognitive similarity-attraction effect is Davis's (1981) consensual validation model. He stated that attitudinal similarity is reinforcing in its own right because it gives desired consonance and constancy and serves as confirmation that one's view of the world is correct. Psychological research in perception, memory and learning, and self-verification would support a view that people have a desire for affective consonance that is similar to their desire for cognitive consonance or their dislike for cognitive dissonance (Festinger, 1957). For example, the findings of self-verification research (e.g., Swann et al., 1990; Swann, Stein-Serroussi, and Giesler, 1992) demonstrate the importance of consonance, that having one's own feelings validated can be more important than a positive evaluation when the other's evaluation is in conflict with one's own evaluation. Also, affective congruence is posited to offer a necessary conceptual coherence (Niedenthal and Halberstadt, 1995), similar to the coherence gained from the cognitive consistency discussed by Newcomb (1961).

There is also direct evidence for affective-similarity attraction effects, particularly in studies of the similarity-attraction effects of being in a very low positive affect state, or depressed mood (e.g., Rosenblatt and Greenberg, 1991). Locke and Horowitz (1990) showed that similarity in dysphoria (similar to low positive affect), irrespective of actual dysphoria, is the critical determinant of satisfaction with a dyadic interaction and that this satisfaction increases as the length of the interaction increases. Lastly, Davis (1981) also proposed a "rewards of interaction model," which states that **value**/cognitive similarity is attractive because it leads to future expectations of rewarding interpersonal interaction (e.g., behavior, activities, and communication). The same processes and rewards should occur with affective similarity: "If I enjoy being with you affectively, I will be more likely to give you other rewards, including interacting with you more." Individual-level Attitudes and Self-Perception Satisfaction. Affective diversity should influence individual levels of satisfaction with the group. The more similar a group member is to others in the group in positive affective personality, the more satisfied that group member should be with the group's interpersonal relations (e.g., Locke and Horowitz, 1990). Researchers have found demographic similarity to be associated with greater satisfaction and commitment (Meglino, Ravlin, and Adkins, 1989; Verkuyten, de Jong, and Masson, 1993), more trusting relationships between negotiation partners (Valley, Mannix, and Neale, 1995), more supportive relationships (Ibarra, 1992), and greater empathy toward similar people in need and thus putting higher **value** on their welfare (Batson et al., 1995). As homogeneity has been shown to lead to greater personal attraction and satisfaction with relationships, and similarity within work teams has been shown to lead to more positive feelings about people in the group, we hypothesize the following:

Hypothesis 1: Individual group members who are more similar to others in their group in trait positive affect will be more satisfied with the interpersonal nature of their group experience than those who are more affectively dissimilar.

Perceptions of individual influence. Another expected outcome of being affectively similar to others is a high self-perception of one's influence level in the group. While the social psychology literature has long established the presence of individuals' tendency to assume that others

will perceive the world as they do, even when there is evidence to the contrary (Ross, 1977; Ross, Green, and House, 1977), this effect of projecting our own opinions and attitudes onto others has been shown to be even greater when we like others or believe that they are similar to us (Vroom, 1959). Research has also shown that similarity, or perceived similarity, also leads people to be more willing to be influenced by similar others (e.g., Cialdini, 1993). For example, Enz (1988) found that perceived **value** congruity between senior managers and department members led to greater departmental power, as perceived by both the department members and the senior management. Thus, we hypothesize:

Hypothesis 2: Individual group members who are more similar to others in their group in trait positive affect will perceive themselves as having greater influence within the group than those who are more affectively dissimilar.
Group Level Social Processes Cooperation and conflict. Following from the argument for satisfaction on the individual level, affectively homogeneous groups should be more cooperative and have less conflict than affectively heterogeneous groups because of the greater feelings of familiarity, attraction, and trust that are engendered from affective similarity-attraction processes. These reinforcing effects of similarity in affect will then be associated with more cooperative and cohesive group processes. There is ample support in the diversity literature for this process occurring. A team's demographic heterogeneity, on a variety of factors, has been found to be related negatively to team rapport (O'Reilly, Snyder, and Boothe, 1993) and informal communication among team members (Smith et al., 1994). Similarly, a group's demographic heterogeneity has been found to impede teamwork and to lead to difficult information exchange (Ancona and Caldwell, 1992). With regard to intragroup conflict, there is evidence that differences in demography (Alagna, Reddy, and Collins, 1982; Pelted, 1996b; O'Reilly, Williams, and Barsade, 1998) and personality (Haythorn et al., 1956) lead to increased conflict. The construct of conflict has often been divided into two areas, relationship conflict, pertaining to interpersonal incompatibility among team members, and task conflict, pertaining to disagreement about how the group tasks should be performed (Pinkley, 1990; Jehn, 1995). Jehn and her colleagues have found relationships between demographic variables and both types of conflict (e.g., Jehn, Northcraft, and Neale, 1996; Jehn, Chadwick, and Thatcher, 1997). We therefore propose: Hypothesis 3: Affectively homogeneous groups will have greater cooperation and less task and relationship conflict than will affectively diverse teams.

Participative leadership style. Leaders are expected to be participative in leading their groups when they perceive them as being affectively similar to themselves. Pfeffer (1983) discussed how perceived homogeneity in demographic characteristics, particularly length of time employed in the organization, can lead to less reliance on formal, bureaucratic controls in organizations than on informal, more **value**-based control (e.g., Ouchi, 1981). The rationale is that the attraction, comfort, and reinforcement that comes from feeling similar will assure members that the appropriate group behaviors will be followed without the need for formal rules or controls. A psychological parallel to this can be found in a study by Gruenfeld et al. (1996), who found that groups of people who are comfortable and familiar with each other perform better than groups of strangers in a problem-solving task in which information sharing is necessary, a situation similar to that of top management teams. Westphal and Zajac (1995) found that the less demographic distance between the CEO and the board, the less the tendency for directors to challenge managerial preferences in the name of shareholder interests. A similar rationale can be applied to chief executive officers (CEOs) ceding more power to their teams. As Smith et al. (1994: 415) discussed in their study of top management team demography and social process, diverse teams may be viewed

as less predictable in their attitudes and behaviors than homogeneous teams, and thus predictability and control will likely be enforced by the CEO through monitoring (Holmstrom, 1979) and rules and regulations (Eisenhardt, 1989). We reason that leaders who feel similar to their teams trust their teams' perspectives to be similar to their own and will be more likely to give their teams greater decision-making power:

Hypothesis 4: Similarity in trait positive affect between a group leader and his or her group members will lead to the leader's using a more participative than autocratic decision-making style.

Group Performance There are competing theoretical arguments and empirical results relating to the effect of diversity on performance, and an extensive literature on the antecedents of group performance has arisen. Many researchers have found that there are negative effects of diversity, as heterogeneity creates distance between group members, which makes trust, rapport, social integration, and communication less likely (O'Reilly, Caldwell, and Barnett, 1989; Zenger and Lawrence, 1989; Tsui, Egan, and Xin, 1995), leading to implementation problems (Simons, 1995) as well as turnover (Jackson et al., 1991). Other researchers have argued-based on the theoretical argument laid out by Hoffman and Maier (1961)-that group heterogeneity enhances the breadth of perspective, viewpoints, cognitive resources, experiences, and general problem-solving ability of the group and that diversity can therefore help enhance performance (e.g., Cox, Lobel, and McCleod, 1991). As there is currently no clear consensus about how heterogeneity influences performance outcomes (Guzzo and Dickson, 1996), and as different dimensions of diversity have different impacts, we discuss each perspective below and posit competing hypotheses on the influence of trait positive affective diversity on group performance. Affective homogeneity. There is substantial evidence that demographic homogeneity can positively influence group performance (see Williams and O'Reilly, 1999, for a review). As we predicted in hypothesis 3, affective homogeneity should lead to greater cooperation and less conflict. Greater cooperation and less conflict should reduce friction and increase efficiency in task performance, particularly with complex tasks that require information sharing, such as those facing top management teams. In a study of top management teams, Bourgeois (1980) found that disagreement and lack of cooperation were associated with decreased performance. Amason (1996) differentiated between cognitive conflict and affective conflict, and although cognitive conflict had a beneficial impact on decision making, affective conflict had a negative impact. Cognitive conflict concerning the merits of the ideas enhances decision making by allowing the group to refine and reject suboptimal solutions, while affective conflict is often directed more at the person than the idea, proving more destructive and isolating and thus reducing group effectiveness. Pelled (1996a) argued that performance may be reduced in groups in which there is affective and substantive conflict due to anxiety, psychological strain, lack of receptivity to ideas, and inability to assess new information-energy is spent on the conflict instead of the task. These process losses may lead to the poorer implementation found in heterogeneous teams (Simons, 1995).

In highly complex tasks, such as those facing a top management team, though informational diversity should theoretically be more beneficial than in routine tasks, this does not always play out in practice. O'Reilly and Flatt (1989) found that top management teams with homogeneous organizational tenure were more creative than teams with more diverse tenure. Dougherty (1992) found that cross-functional product teams had difficulty getting their products to market, and Ancona and Caldwell (1992) found managers' ratings of innovativeness to be lower when teams were functionally diverse than when they were homogenous. Thus, we predict the following:

Hypothesis 5a: Affectively homogeneous groups will have better group performance than will affectively diverse groups.

Affective heterogeneity. There is also support in the demography and group performance literatures for negative outcomes of group homogeneity and positive outcomes of heterogeneity, or diversity, particularly as it promotes debate or conflict over the task (see Milliken and Martins, 1996, for a review; Watson, Kumar, and Michaelsen, 1993; Jehn, 1995). Amason and Schweiger (1994) proposed that the positive aspect of task conflict is that it allows group members to identify and discuss diverse perspectives, thus increasing the evaluation of the criteria needed to make a high-quality decision. This is particularly true when the task requires creative problem solving and innovation, as the availability and expression of alternative perspectives can lead to novel insights (Nemeth, 1986). Most researchers studying top management teams have found positive relationships between top management team diversity and innovation (Bantel and Jackson, 1989), company growth rates (Eisenhardt and Schoonhoven, 1990), firm performance (Roure and Keeley, 1990), and effectiveness in responding to competitors (Hambrick, Cho, and Chen, 1996). Also, findings in social psychological research can help explain this with findings showing that group uniformity may be "secured at the expense of group success and group adaptation to the environment" (Moscovici, 1985: 350) and that a desire for uniformity can lead to an inability for group members to criticize and challenge ideas within the group, what Janis (1982) referred to as "group think." Thus, we also posit a competing hypothesis to the one above:
Hypothesis 5b: Affectively diverse groups will have better group performance than will affectively homogeneous groups.

Mean Level of Trait Affect Though the literature on the relationship between affect and group-level performance variables is quite small, there is a vast body of research examining mean affect and judgment and performance tasks on an individual level, and there may be a parallel between the individual and group processes (Kelly and Barsade, 2001). Almost all research examining group-composition effects related to affect has concentrated on the relationship between the mean level of affect and various group processes and outcomes (e.g., George, 1990, 1995). As a result of this literature, two different perspectives regarding how positive emotional influence relates to individual attitudes, interpersonal processes, performance, and judgment have emerged. The first literature stream, as exemplified by research conducted by Isen and colleagues, has shown a beneficial direct effect of positive affect on judgment. For example, inducing positive mood leads to greater creativity, more efficient cognitive processing, and better use of heuristics in complex decision-making tasks, as well as broadened categories for information sorting and greater flexibility in categorization (see Isen, 1999, for a review). Inducing low positive affect (i.e., depressed mood) has also been shown to have a negative effect on cognitive performance (Mitchell and Madigan, 1984; Zarantonello et al., 1984). In contrast, the "depressive realism" literature (e.g., Alloy and Abramson, 1979, 1982; see also Golin, Terrell, and Johnson, 1977; Tabachnik, Crocker, and Alloy, 1983) offers the opposite prediction, which is that lower positive affect will lead to beneficial results in organizationally relevant contexts, as those who are more depressed will be more realistic and less likely to make mistakes in judgment based on selfenhancement biases. Staw and Barsade (1993) directly tested these two competing hypotheses, using trait positive affect as their predictor variable. Examining the relationship between trait positive affect and performance in a series of managerial simulations, they found that better decision making, social interaction, and leadership ratings were found in subjects high in trait positive affect than in those low in trait positive affect, giving support to the view that higher trait positive affect will lead to better individual attitudes, group processes, and performance outcomes. Thus, while it is not the focus of our study, we

expect to find a positive relationship between the mean level of a team's trait positive affect and individual attitudes, group processes, and performance. We have hypothesized that the affective diversity effects discussed above will hold true regardless of whether the group is pleasant or unpleasant, yet given the inherently negative valence of unpleasant emotion, it is natural to question whether mutual unpleasant emotion can also be positively reinforcing. There is evidence on both sides of this case. Even for unpleasant affect, research has shown that people with a negative self-perception prefer for others to see them as they see themselves-their desire for self-confirmation overcomes their desire for positive evaluation (e.g., Swann et al., 1990; Swann, Stein-Serroussi, and Giesler, 1992). There is also a large body of research showing that depressed people (e.g., Byrne, 1971; Rosenblatt and Greenberg, 1991) or those about to undergo an unpleasant experience (e.g., Schachter, 1959) prefer to engage with people perceived as being in a similar situation (e.g., Miller and Zimbardo, 1966; Gibbons, 1986; Hogue and Steinberg, 1995).

While the preponderance of evidence seems to support a completely homogeneous attraction-similarity effect, regardless of the mean level of affect, there is some evidence that would support an interaction effect between affective diversity and the mean level of affect, such that homogeneity in low-positive-affect groups could lead to different group outcomes than homogeneity within high-positive groups. There is support from motivated cognitive processing theory (Clark and Isen, 1982; Forgas, 1991) for the benefit of injecting pleasantness into a group Osen, 1985; Saavedra and Earley, 1991). Studies show that, on average, people avoid situations that would reduce their positive emotions Osen and Simmonds, 1978; Isen, Nygren, and Ashby, 1988) and that they seek out and remember pleasant experiences more than unpleasant experiences (Singer and Salovey, 1988). Thus there is sufficient cause to test for interaction effects beyond our main homogeneity effects. Because this is an exploratory **analysis**, however, and these interactional effects could take a variety of forms, we do not posit a formal hypothesis here but, rather, conduct a conservative test for the interaction. The model developed through the theory above is shown in figure 1. We use this model to examine the influence of an individual's trait positive affective fit with his or her work group and then explore the contributions of positive affective diversity (that is, affective homogeneity and heterogeneity), mean level trait positive affect, and the interaction of these two variables on individual attitudes and group processes and performance through an examination of trait positive affective diversity in the context of ongoing top management teams. METHOD

Sample The sample consisted of the CEOs of 62 U.S. companies and 239 of their top managers. The sample was derived from the participants at two CEO conferences held at an East Coast university. Invitees to both conferences were executives of leading organizations in their fields. The first conference invitation list consisted of CEOs from the Fortune 500 industrials; the largest 100 privately held companies in the U.S.; leading service companies (e.g., the top 25 advertising agencies and law firms, the top 10 consulting firms, the Big 6 accounting firms, etc.); leading not-for-profit organizations (including government agencies, educational institutions, professional associations, health research organizations, philanthropic organizations, and environmental organizations), and a small number of newsworthy emerging-growth companies. Invitees to the second CEO conference were CEOs from the largest 250 companies listed on the NASDAQ Stock Exchange (size defined as market capitalization).

Because of the nature of the conferences, we were in the unusual position of being able to obtain self-report trail affect, demographic, attitudinal, and group dynamic data from the CEOs and their senior management teams. The

procedure for this was as follows: CEOs who registered for the CEO conferences were sent the questionnaire to complete before arriving at the conference. The questionnaire included trait affect items and demographic questions (as well as other items not related to this study). The questionnaire was an integral part of the general group feedback CEOs were to receive about themselves and their CEO peers at the conference, and CEOs were also told that they would be given individualixed personality reports anout themselves and their senior management team. We believe this assisted in obtaining the high CEO response rate of 67 percent. As part of the questionaire, we asked CEOs to list the names of their top management team members and requested permission to send these managers a questionnaire as well. Having the CEO list his or her top management team members allowed us to access directly (rather than infer from job titles) the people whom the CEO considered to be members of the top management team. CEOs listed an average of 4.41 top managers (s.d. = 3.07), and we mailed a questionnaire to each of these. The top management team's response rate for the questionnaire was also high, at 70 percent. The top management team questionnaire consisted of individual trait affect items, individual satisfaction and perceived influence measures, demographic information, questions about team-level conflict and cooperation, and an assessment of the degree of participativeness versus autocratic decision-making style of the CEO (as well as other questions not related to this study). To be included in the final sample, the CEO and at least two top managers had to complete the survey. This excluded 39 organizations, leaving 62 organizations in the final sample.

Figure 1.

The final sample of 62 organizations varied across industry and covered the profit (both private and publicly held) and not-for-profit sectors. The publicly held companies performed slightly above the market average, with a mean marketadjusted return in 1995 of .038 (s.d. = .209). Many were newer companies, with half founded after 1971. The sample also included some older companies, which brought the mean company age to 40.46 years (s.d. = 38.24).

Positive Affective Team Composition Variables Individual trait positive affect (PA). Trait PA is people's tendency toward pleasant emotional engagement with, or appraisal of, their environment (Staw, Bell, and Clausen, 1986). High PA is characterized by high levels of enthusiasm, energy, mental alertness, and determination, while low PA is characterized by down-heartedness, dullness, and sluggishness (Watson and Tellegen, 1985). We measured trait PA with the highly reliable and valid Well-Being Scale from the Multidimensional Personality Questionnaire (MPQ), formerly called the Differential Personality Questionnaire (Tellegen, 1982). For use here, the scale was converted from a true-or-false format to a 7-point Likert-type scale. Sample items are "I always seem to have something pleasant to look forward to," "I often feel happy and satisfied for no particular reason," and "Most days I have moments of real fun and joy." The mean of the 11-item PA scale was 5.48 (s.d. = .80), and the Cronbach alpha reliability was .87. To ensure that we were not missing an affective component of these teams, we also created team compositions variables assessing trait negative affect in the teams which were analogous to the positive affect variables. Descriptions of these variables can be found in Appendix A.
Affective diversity was measured through heterogeneity in trait positive affect at both the individual and team level. To measure diversity at the individual level, we followed Tsui and O'Reilly (1989) by calculating each top management team member's relational demography score, his or her affective dissimilarity from the rest of the senior management team, using the formula for Euclidean distance: where Si = the respondent's own score on the dimension being examined (e.g., dispositional affect), Si = each of

the other top management team members' score on the dimension being examined (e.g., dispositional affect), and n = the number of senior managers on the top management team. This method is commonly used (e.g., O'Reilly, Caldwell, and Barnett, 1989) to examine how different an individual is on a particular dimension from each of his or her fellow group members. The mean trait PA relational demography score for the entire top management team (including the CEO) was 1.01 (s.d. = .45). We also used each CEO's trait PA relational demography score separately as the predictor variable for affective diversity when examining the CEO's participative decision-making style. The mean trait PA relational demography score for the CEOs was .94 (s.d. = .38).

To measure group-level affective diversity, we used the standard deviation of the top management team's trait PA, instead of the often used coefficient of variation, because our primary predictor variable, trait PA, was measured on an **interval** rather than a ratio scale (Allison, 1978). The standard deviation was also useful in our analyses in testing for the separate effects of the mean and the variance in the same equation and in testing interaction effects. The standard deviation of the top management teams ranged from .18 to 1.58, with a mean standard deviation of .71 (s.d. = .25).

Mean level trait positive affect. Group-level trait positive affect was calculated as the average of the team members' trait PA scores, including the CEO (x = 5.51, s.d. = .37). For individual-level analyses, we calculated a variable to control for the trait PA of the other members of the team. This variable represents the mean trait PA of everyone minus the self (x = 5.52, s.d. = .41).

Perceived group positive culture. To control for perceptual biases in the individual-level analyses, we measured team members' (not including the CEO) perceptions of the positive affective culture in their top management team by having them rate the following three items: "The emotional culture of our top management team is enthusiastic and cheerful," "The emotional culture of our top management team is pleasant as opposed to unpleasant," and "The emotional culture of our top management team is depressed, sluggish and gloomy" (reverse coded). We calculated a perceived team positive culture score for each team member by taking his or her mean rating on the three items (scored on a 7-point Likert scale; 1 = Strongly Disagree through 7 = Strongly Agree). The mean perceived team positive culture was 5.68 (s.d. = 1.21) and the Cronbach alpha reliability was .81. This perceptual measure differs from the trait PA measures in that it is not a measure of stable personality dispositions but, rather, is meant to indicate team members' general feelings about their team. Dependent Variables Individual-level attitudes and self-perceptions. Our measure of satisfaction with team interpersonal relations came from team members' answers to the following three questions on how satisfied they were with (1) the way they were treated by other members of the top management team, (2) the way they were treated by the CEO, and (3) the interpersonal relations between top management team members. They rated each item from 1 to 7 (1 = very dissatisfied through 7 = very satisfied), and the mean of this scale was 5.55 (s.d. = 1.16), with a Cronbach alpha of .73. We assessed self-perceptions of influence within the team by asking team members the following two questions: (1) "I feel I have a great deal of influence on the CEO regarding decisions within my area of responsibility," and (2) "I feel I have a great deal of influence on decisions made by the top management team." These items were assessed on a scale of 1 (Strongly Disagree) through 7 (Strongly Agree), with a mean of 5.86 (s.d. = 1.27) and a Cronbach alpha of .70. Group-process measures. We asked senior managers (not including the CEO) about the degree of conflict and cooperativeness in their top management team. For each company, we used the mean of the senior managers' perceptions about the group process (e.g., conflict) as the

group-level dependent variable. We measured group conflict using Jehn's (1995) conflict scale. Task conflict was measured by three items asking about differences of opinions in the top management team, team disagreement about work being done, and general degree of task conflict in the top management team. The mean of each team's task conflict score was 3.54 (s.d. = .89), with a Cronbach alpha of .73. Emotional conflict was measured through a four-item scale that asked about personality clashes in the top management team, degree of anger, degree of friction, and the general amount of emotional conflict in the top management team. The mean of each team's emotional conflict score was 3.42 (s.d. = 1.11), with a Cronbach alpha of .93.

Group cooperativeness. We combined two scales to make a seven-item group cooperativeness scale. The first scale consisted of the following four items: "There is a great deal of competition between members of our TMT" (reverse coded); "Members of our TMT view themselves as a team"; "When our TMT has done well, I have done well"; and "There is a lot of unpleasantness among people in this TMT" (reverse coded) (Alderfer and Smith, 1982). The second scale consisted of the following three statements: "I benefit when our team as a whole does well"; "Members of this group care a lot about it and work together to make it one of the best"; and "The members of our TMT really stick together" (Wageman, 1995). These items were scored from 1 (Strongly Disagree) to 7 (Strongly Agree), with a mean of 5.26 (s.d. = .63) and a Cronbach alpha of .82.

CEO participative leadership scale. Our CEO participative--leadership-style scale measured each CEO's degree of participativeness versus autocracy as rated by their top management teams. The members of the team completed a 17-item decision-making scale based on a combination of Heller's (1971) and Vroom and Yetton's (1973) leadership style questionnaires (see Appendix B for a detailed description of this scale). Team members were asked about the degree of participativeness of their CEO when dealing with different types of organizational issues, such as strategy, human resources, and **finance**. The higher the rating, the more participative the CEO. The Cronbach alpha for this scale was .90. The ratings were aggregated across each group's top management team members to form a group-level score for each CEO (x = 5.90, s.d. = 1.18 on a 1-10 scale).

Group performance measures. We obtained information on **financial** performance for the public companies in the sample from the COMPUSTAT industrial file and the Center for

Research in Security Prices (CRSP). The variable used to measure **financial** performance was the logged annual market- adjusted return, averaged across each year that the entire top management team (including the CEO) worked together. Market-adjusted returns indicate the company's stock returns minus the return on a **value**-weighted market index. Market-adjusted returns are a widely used metric to judge firm performance, as they are not biased by overall market performance (Brown and Warner, 1980). They also enable the most equitable comparison of performance across industries, which was necessary for our sample, which was very industry-diverse. We could not use accounting measures, such as ROA (return on assets) or ROE (return on equity), commonly used in studies focusing on a single industry, as they generally provide poor comparisons across industries, especially between people-intensive service industries and capital-intensive manufacturing industries.

Control Variables Demographic variables were not the focus of this study, but because organizational demography and team composition research has shown that various aspects of a team's demographic composition can influence group processes and outcomes, including in top management teams

(see Hambrick, 1994, for a review), the following demographic information was obtained for each top management team member as control data: sex (0 = male, 1 = female); age; years of company tenure; number of years on the top management team; functional background (coded into the following nine categories: general management, **finance**, operations, marketing, human resources, legal, accounting, entrepreneurial, and other); educational attainment (coded as 0 = high school degree or less, 1 = college, 2 = M.B.A./graduate degree); and the prestige of the undergraduate or graduate universities attended.2

Company-level control variables included the age of the company; number of managers on the senior management team (as listed by the CEO); the company's status as public, private, or not-for-profit; and a size index for the public companies (based on market capitalization). Descriptive statistics of these team and individual characteristics can be found in table 1. We controlled for demographic composition in individual-level analyses by including each senior manager's demographic characteristics in the equation, as well as his or her Euclidean distance from the team on each characteristic. In group-level analyses, the team means for the demographic variables were included as well as the team's standard deviations. For categorical variables, such as functional background, we used Blau's (1977) index of heterogeneity instead of standard deviations to index group-level differences. The formula for Blau's index (1977) is 1 - Y.pi2, where p equals the percent of individuals in a category and i equals the number of different catviduals in a category and i equals the number of different measured.

Table 1

To reflect the finding meas of previous organizational demography studies, and to conduct a more conservative test of the findings of previous organizational clemography studies, and to conduct a more conservative diversity variable, all of the demographic characterisaffective diversity val, group-level, and relational of the demographic measures listed individual, group-level, and re entered on the first step of a hy merarchical regression in table 1 were entered on the first step of our analyses. Only those variables found to be significant were entered in each of our analyses. Only those analyses and are listed in the correlation matrix in tables found to be significant were entered in subsequent and 3.

RESULTS The means, standard deviations, and intercorrelations among all variables used in the analyses are reported in tables 2 and 3. The hierarchical regression in table 4 (model 1) supports hypothesis 1. Controlling for the demographic and affective control variables, there was a significant effect of affective diversity. The more similar in trait positive affect (PA) a team member was to his or her fellow team members, the greater his or her satisfaction with the interpersonal relations on the top management team. There was no significant effect of mean trait PA and no interaction effects between mean trait PA level and affective diversity. Model 2 shows that, as predicted by hypothesis 2, controlling for demographic and affective controls, there is a significant effect of affective diversity: The more effectively similar a team member is to the trait PA of others in his or her team, the greater is his or her perceived influence. No main effects of mean trait PA level or interaction effects between mean trait PA level and affective diversity were found.

Table 2

Table 3

Table 5 shows the hierarchical regressions examining the influence of trait positive affective diversity on group dynamics. Mean TMT trait PA level is

significantly positively related to group cooperativeness, but there is no significant effect of affective diversity on cooperativeness. There is, however, a significant interaction effect between mean team trait PA level and trait PA affective heterogeneity. To examine the form of the interaction, we divided the sample into four groups according to a median split on each of the two variables making up the interaction. Figure 2 shows that the interaction comes from the significantly lower level of cooperativeness of groups that are affectively diverse and have a low level of mean trait PA as compared with the other three groups: high mean level trait PA and affectively diverse, high and low mean level of trait PA, and affectively homogeneous The results in table 5 for task and emotional conflict are very similar to those for group cooperativeness. Controlling for the demographic variables (mean tenure level and number of managers from the same university as the CEO), mean trait PA level had a significant negative effect on task conflict and a marginally significant effect on emotional conflict ($p < .10$). As with group cooperativeness, no significant main effect of affective diversity was found. There was a significant interaction effect between mean trait PA level and affective diversity for each type of conflict. Figures 3 and 4, which diagram the forms of these two interactions using a median split on both variables, show that the interactions are very similar to each other, and to group cooperativeness, with the affectively diverse groups low on mean trait PA being higher than the others in the level of task and emotional conflict. Thus,

Table 4

hypothesis 3, which predicted that more affectively homogeneous groups will experience greater cooperativeness and less conflict, was not directly supported. Rather, it was indirectly supported in the context of the interaction: homogeneous groups have equal levels of cooperativeness and task and emotional conflict, regardless of mean trait PA. In contrast, affectively diverse groups that have high mean trait PA levels are characterized by greater cooperativeness and lack of conflict than are affectively diverse groups with low mean trait PA levels. Thus, increased stressful social relationships were found in affectively diverse, low mean trait PA groups as compared with the other three groups.

Table 5

Figure 2.

The results for hypothesis 4 can be seen in table 6. As this variable focused on the CEO's decision-making style, rather than group processes as a whole, we included CEO trait PA in the equation, as well as the degree of difference between the CEO's trait PA and that of the other team members. Con trolling for demographic variables (mean TMT member company tenure) in a hierarchical regression, there was no signifi cant effect of CEO trait PA on participativeness in

decision-making style. As predicted in hypothesis 4, there was a marginally significant effect of affective diversity in the predicted direction. CEOs who were more similar to the mean trait PA of their senior management team had a marginally significantly more participative than autocratic decision-making style. There was no significant interaction between affective diversity and mean level affect on CEO decision-making style.

As **financial** performance has been discussed as influencing group processes (Ocasio, 1995), we also included this variable as a control in all of the group process variable regressions reported above, but there was no significant relationship between **financial** performance and group cooperativeness, task conflict, emotional conflict, or degree of CEO

participativeness.

Figure 3.

Figure 4.

Lastly, we examined whether affective diversity would hinder (hypothesis 5a) or help (hypothesis 5b) group performance by examining the **financial** performance of the publicly held organizations in our sample. The results are shown in table 7. Controlling for differences from other TMT members in functional background (which was significantly positively related to **financial** performance) and mean trait PA (which was not significantly related to **financial** performance), a hierarchical regression showed that trait PA homogeneity was marginally significantly related to firm **financial** performance. The more affectively diverse the team was in trait PA, the lower the company's logged market-adjusted return over the mean number of years the team had been together. The interaction effect of affective diversity and mean level trait PA on **financial** performance was not significant. Thus, there is marginally significant support for hypothesis 5a, that groups that are homogeneous

in their trait PA will have better performance.

As we discussed earlier, group process measures can influence **financial** performance as well, so we entered degree of group cooperativeness, task and emotional conflict, and degree of CEO participativeness as controls in our equation prior to entering the affective diversity variables. None of these variables was found to be significantly related to **financial** performance. Exploration of Trait Negative Affect We conducted exploratory hierarchical regression analyses for trait negative affective diversity using the variables described in Appendix B. These analyses were identical to those conducted for trait positive affective diversity. No effects for trait negative affective diversity, either at the individual level or at the group level, were found. There were also no significant effects of mean level negative trait affect on any of the dependent variables.

Table 6

Table 7

DISCUSSION Teams are increasingly becoming primary in the way employees in organizations conduct work (Guzzo and Shea, 1992; Jackson, 1991). The effects of similarities and differences among team members have been shown to influence every aspect of that work. In this study we expanded on the classic examination of demographic differences to include differences in personality and emotion through trait positive affect. We found that trait positive affective diversity does make a difference in individual group members' attitudes, group processes, and group performance. Examining these differences provides a particularly interesting empirical test of the oft-stated rationale for poor team performance: personality clashes, the effects of which have been shown to be particularly strong in group settings (see Mikolic, Parker, and Pruitt, 1997).

The greater the fit in trait positive affect (PA) between top management team members and their fellow team members, the higher their satisfaction with interpersonal relations within the team and the higher their perceptions of their amount of influence on the team. A similar trait PA fit between the CEO and the rest of the team is associated with a marginally significantly greater use of participative than autocratic decision making by the CEO. This marginally greater CEO participativeness

is additional evidence that members accurately feel that they have more influence when

they are in more affectively homogeneous teams.

When examining group process, we found an intriguing, and unexpected, interaction effect that can be characterized by the first line of Anna Karenina: "All happy families are like one another; each unhappy family is unhappy in its own way" (Tolstoy, 1961: 17). Happy, or high trait PA top management teams, had the same relatively higher levels of cooperativeness and lower levels of task and emotional conflict, regardless of affective diversity. "Unhappy" teams, or teams lower in trait PA, were unhappy in their own way, depending on their level of affective diversity. Low trait PA teams with low affective diversity had levels of cooperativeness and conflict similar to those of the happy teams. But low trait PA teams with high levels of affective diversity were significantly lower in cooperation and higher in conflict than the other three groups. Thus, for group conflict and cooperativeness, being homogeneous compensated for low trait PA, and being high in trait PA compensated for being affectively diverse, but nothing ameliorated the effect of being affectively diverse and having mean low trait PA.

These affective compensatory effects did not extend, however, to company **financial** performance. No interaction between mean level of trait PA or PA diversity was found, and no effects of mean trait positive affect were found: whether a TMT comprised dispositionally happier or sadder members had no relationship with **financial** performance. Rather, there was a marginally significant negative relationship between affective diversity and firm **financial** performance: more affectively diverse top management teams had poorer **financial** performance than did teams more homogeneous in trait PA. This result contrasts with our finding for the effect of a more standard measure of diversity-functional background-on performance. We found that top management team functional heterogeneity was associated with greater **financial** performance, which conforms with literature we cited earlier supporting the positive effects of some types of demographic heterogeneity and empirical findings on top management teams (Hambrick, Cho, and Chen, 1996). Although the broad nature of our sample (across both industry and sector) generally helped to support the generalizability of our results, it hindered our ability to establish a standardized measure of organizational performance in that we were only able to test the performance hypothesis with the publicly listed firms in our sample. Despite this limitation, and the consequent reduction in the number of organizations in the sample for this hypothesis, our beta was quite large (B

-.30). Accordingly, we believe this result will be even stronger if replicated in a study with a larger sample size or one in which performance is comparable across all organizations. Also, this result is particularly exciting given the inherently loose relationship between top management team dynamics and firm **financial** performance. 3

Interestingly, when we examined whether the affective-diversity effect on **financial** performance was moderated through group process variables, we found no significant relationships between group process variables and **financial** performance. This is puzzling, but it may be that in dealing with their difficult group processes, affectively diverse group members have an individual-level side-effect of being psychologically distracted, which siphons away their ability to focus well on their task above and beyond the group process losses. Also, as Hackman (1983: 257) pointed out, "Too often managers or consultants attempt to 'fix' a group that has performance problems by going to work directly on

obvious difficulties that exist in members' interpersonal processes. And, too often, these difficulties turn out not to be readily fixable because they are only symptoms of more basic flaws in the design of the group or in its organizational context. Process is indeed an important thing, but it is not the only thing." The affective diversity and composition of the team is one of these fundamental design aspects.

Although it was not the focus of our study, we found support for the literature showing the importance of mean trait positive affect in group process (e.g., George, 1990) but no support for its impact on group performance. It may be that the costs and benefits of each of the positive and negative affective influence processes we discussed earlier canceled each other out, while the benefits of the affective-similarity

process remained constant. Also, the mean trait PA level was quite high among these top management teams, which might be expected, as having high trait PA may be more necessary on a top management team than in other jobs. This does restrict the range here, but it leads to a more conservative test.

As an exploratory test, we also tested for the effects of diversity in trait negative affect (NA) and found no relationships for either trait NA diversity or mean level trait NA measures with any of the outcome variables. Given prior research showing trait NA's explicit lack of relationship with social variables (e.g., McIntyre et al., 1991; Watson et al., 1992), it is disappointing, but not surprising, that train NA had no effect in this situation. We do not think that this is evidence that negative affect is irrelevant to groups. Rather, we believe that the more general, overarching construct of trait negativity may be more related to internal states and therefore may not be the best type of negative emotion to study in the group context. There may still be fruitful avenues for understanding the roles of other, more social, negative emotions in groups, such as anger and anxiety.

Also, our model focuses on trait positive affect, but only as a first step. We think the model should be equally relevant and extend to other types of affect. The next step in this line of research is to examine other affective variables explicitly. For example, having established that affective traits are important to group composition, we would want to extend this inquiry to the influence of particular affective states. Affect state has been shown to be a very important determinant in forming impressionAsch, 1946; Hastorf, Schnider, and Polefka, 1970), and affective cues have been used to make inferences about different aspects of a person's personality (e.g., Katz and Braley, 1933). The saying that first impressions count has been supported in this research on impression formation, which may indicate that studying state affect may be particularly important in groups that stay together for short periods, such as juries or task forces. This is different than in top management teams or other situations in which groups stay together for a longer period of time. The repeated encountering of a person's affective states over prolonged periods is likely to relay both a stronger and more accurate impression of the person, overcoming any false first impressions, and is thus more likely to guide responsive behavior. This is especially true as teams work together over time, as team members get to know the affective personality of their peers, how each other works, and as they accommodate each other's styles through social entrainment (McGrath, 1991). As such, the tenure of the group and of individuals within the group could also become an important component or moderator of the similarity-attraction process as it relates to positive affect at the team level.

When thinking about our results, it is natural to question the causation of the effects between affective team composition and team performance. As our

measure of positive affect is a stable and reliable trait (e.g., Watson, Clark, and Tellegen, 1988) shown to be steady over different jobs and time (Staw, Bell, and Clausen, 1986; Watson and Slack, 1993), we find it more likely that it will influence group performance or processes rather than vice versa. Also, while we do not expect a reverse causation of performance on trait PA variables, even if there were such a reverse causation, we would expect it be less related to trait affective diversity and more related to mean level trait PA. Yet even this relationship was not found in this study: there was no relationship between **financial** performance and mean level trait PA. While economic adversity has been shown to influence group processes, for example, leading to either the strengthening of cohesive top management groups or the breaking apart of more fragmented top management groups (Ocasio, 1995), our model would suggest that this would not occur through a direct influence on trait positive affect but, rather, by its influence on individual perceptions and group social processes, such as cooperation. This is not to say, however, that we do not think performance can influence other types of affective variables that we think should be studied in an affective diversity context. For example, in the more malleable case of mood as the predictor variable, we would fully expect to see a feedback loop between team performance and individual- and grouplevel mood.

Affective Diversity in Top Management Teams There were several advantages in studying affective diversity in top management teams in particular. As the work of top management teams almost exclusively involves decisionmaking tasks, it is similar, in this respect, to much of the classic research on which most of the demography research is based. Also, TMT membership tends to be fairly stable (in our sample TMT members had been with the team for an average of seven years), and TMTs are functionally quite comparable, serving essentially the same collective function across organizations. With regard to understanding executive leadership in particular, we had the rare and fortunate opportunity to conduct our research on existing top management teams and have members of those teams answer (with a remarkable response rate) questions about their personal affect, attitudes, and interpersonal dynamics.

There are some drawbacks to studying top management teams, however, which suggest that it would be useful to replicate this study on other types of teams. First, as compared with teams at lower levels of the organization, these teams were quite homogeneous in some of their internal demographic characteristics (e.g., sex, race, and age), which could influence the effect of affective diversity. The influence of affective diversity in more demographically heterogeneous teams could have interesting implications for the team composition literature. For example, it may show that in such teams, affective diversity is less influential because people are focusing on other differences, such as sex or race. Or, to the contrary, it may serve an ameliorative function, helping people to find affective common ground despite their demographic diversity.

There are similar interesting issues raised when thinking about the role of affective diversity in a cross-cultural context. While there is some debate about the degree of universality of facial expressions (e.g., Russell, 1994; Ekman, 1999), a recent meta-**analysis** by Elfenbein and Ambady (2000) showed that basic emotions can be understood across cultures but that there is an "in-group advantage," in that people from the same culture are capable of understanding each other's emotions better than those from different cultures. This could lead to varying outcomes of affective diversity in different cross-cultural situations, depending on the degree to which people are able to read each other's affective signals accurately. If people can understand each other well affectively, then affective similarity can serve the ameliorative function discussed above, helping to bridge cultural barriers. If, however, people are

misinterpreting each other's affective signals, this could lead to even greater problems and an illusory affective diversity that does not exist and worsens any existing cross-cultural difficulties. There is already some preliminary work showing the importance of looking at how cultural norms, such as individualism and collectivism, interact with demographic characteristics to influence group processes and outcomes (Chatman et al., 1998).

Secondly, replications with a different type of team performance may be useful, since although the top management team is collectively responsible for organizational performance, there are many factors that combine to influence the organization's overall performance and reduce the degree of control the team has over the final outcome. Also, the appropriate measure of performance can vary across organizations. While we were able to gather a measure of **financial** performance for the publicly traded companies in our sample, **financial** performance is not an appropriate measure for some organizations, particularly for not-for-profit or public-sector organizations. The last drawback to testing our hypothesis in top management teams is that the level of interdependence of the team in producing its outcome can be questionable. There has been considerable debate in the field as to the appropriateness of the label "team" for this collection of individuals or whether "top management group" is a more descriptive label (Hambrick, 1994). The interdependence of the team may well have important consequences for how decisions are made (Michel and Hambrick, 1992) and whether the outcome is a result of any group process or merely comes from individual contributions. Our results indicate that although most of the top management groups in the study do consider themselves to be teams, both paradigms may be valid, and in fact, the level of interdependence and shared decision making may vary systematically. Michel and Hambrick (1992) argued that the level of diversification of the firm determines the degree of integration it needs across business units, which in turn determines the ideal composition of the top management team and the degree to which it acts as a team versus a group of individuals. An additional interpretation suggested by our results is that the degree to which the team acts as a team rather than as a group may be as much due to the affective composition of the group as to the nature of the task at hand, which is consonant with research showing that individuals have to be satisfied with other group members, and be motivated to sustain a relationship with them, to have social integration (Katz and Kahn, 1978; Shaw, 1981). Thus, affective diversity may play an important role in this relationship motivation process, influencing group processes and group outcomes. This leads to one of the practical applications of this study, which is that it can help managers make more informed and complete decisions about the factors to consider when deciding how to put their teams together. It can also aid managerial insight into why and how current teams are functioning, by taking affect and personality explicitly into account.

CONCLUSIONS This study has ramifications for the literature on emotions in organizations, group composition, and top management teams. For the literature on emotions in organizations, this study offers an additional conceptualization of the construct of group emotion and shows that affective diversity can influence group dynamics and performance. Our study shows that when examining emotions and personality, one needs to take into account not only the mean affective level of each group member but also the group's affective diversity and the relative similarity, or affective fit, of each member to the other group members. Also, while we focused on the overarching and stable construct of trait positive affect, there are many areas to explore in affective diversity, including moods and more specific emotions such as anger, disappointment, and joy. For the group composition and demography literatures, we offer a new compositional variable, which operates on similarity-attraction principles but differs in its emphasis on

affective versus cognitive similarity as a reinforcer. Affective diversity may be able to explain contradictory effects in this literature, both in its own right and in its interaction with other demographic variables. At the same time, the fact that we found effects similar to those of attitudinal similarity offers support for the theoretical underpinnings of the team composition literature and shows that similar effects can occur with variables not inherently tied to demographics. Finally, our study contributes to the growing literature on the dynamics of top management teams, particularly the conditions under which the top management team may act as a team rather than a group, as described above. Also, the use of CEOs and their senior management teams as a sample has relevance for helping to understand executive leadership. This is particularly important given the great impact top management teams can have on organizational outcomes. Furthermore, because of the inherent difficulties in gaining access to top management teams, personality and other psychological variables have been little studied in top management teams (Hambrick, 1994). This does not mean that psychological variables are not important in top management; on the contrary, they may be even more vital at this level. But most likely because of this lack of access, there has been little work on executive personalities, and most of the research that has been done has focused primarily on dysfunctional personalities (see Kets de Vries and Miller, 1986, for a review). We add to this literature on executive personality by focusing on the influence of "normal" personality characteristics. The continuing study of affective diversity can help to deepen our understanding of both the emotional and compositional components of work group functioning. This can help us add to our current knowledge of the influence of demographic, functional, and cognitive diversity through a more fine-grained **analysis** of the influence of psychological personality characteristics and the influence of emotions in groups.

The authors would like to thank Rod Kramer, Linda Johanson, and three anonymous ASO reviewers for their wonderful guidance and fabulous reviews. Thanks also to Donald Gibson, Barry Staw, John Turner, and Batia Wiesenfeld for their comments and help throughout the paper. Partial support for this article came from the Fred Frank Fund, Yale University.
I

McIntyre et al. (1991: 67) reviewed numerous studies showing that trait positive affect (PA), but not negative affect (NA), is related to "diverse indicators of social activity and interpersonal satisfaction," while NA, but not PA, is related to 11 somatic complaints, psychopathology, and self-reported stress." They tested this finding by examining the effects of two induced social interactions on positive and negative mood. They found that state positive affect (i.e., mood) was influenced significantly by social interaction, while state negative affect was not changed at all. Similarly, Watson et al. (1992) found no consistent relationship between either state or trait negative affect with measures of social activity, while finding a consistent significant relationship between positive state and trait positive affect with social activity. This is likely because negative affect has been strongly related to more internalized states such as stress reaction, alienation, and aggression, as compared with the more externally oriented states of social closeness and social potency with which trait positive affect is related (Almagor and Ehrlich, 1990).

2

Undergraduate and graduate school prestige was coded as follows: 2 = institution ranks among the top 25 national universities or liberal arts colleges for the top 25 graduate/professional schools for graduate-school prestige variable); 1 = university is ranked lower than 25th; and 0 = TMT member did not complete a Bachelor's degree for M.B.A., or other advanced degree for graduate school variable). We used rankings from U.S. News and

World Report, October 4, 1993, and U.S. News and World Report, March 21, 1994, for undergraduate and graduate institutions, respectively, to calculate these ratings.

3

We attempted to control for outside impacts on performance. We used market-adjusted stock returns, thereby controlling for movements in the market and the general economic factors that affect all firms in the industry, We recognize, however, that organizational performance is still influenced by other factors internal and external to the firm that are outside the control of the top management team

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APPENDIX A: Negative Affective Team Composition Variables

Individual trait negative affect (NA) We used the 14-item Stress Scale from the Multidimensional Personality Questionnaire (MPQ), formerly called the Differential Personality Questionnaire (Tellegen, 1982), to measure trait negative emotionality. Sample items are "I often get irritated at little annoyances," "I sometimes get myself into a state of tension and turmoil as I think of the day's events," and "I sometimes feel 'just miserable' for no good reason." The scale has been found to be a highly reliable and valid measure of the underlying NA construct (Tellegen, 1982). The scale was administered using a 7-point Likert-type scale in place of the original true-or-- false format for greater response range. The scale mean was 2.79 (s.d. 1.06), and the Cronbach alpha reliability was .89.
Negative affective diversity. Similar to positive affective diversity, we measured negative affective diversity through heterogeneity in trait negative affect at both the individual and team level. The mean trait NA relational demography score for the entire top management team (including the CEO) was 1.39 (s.d. = .57). We also used each CEO's trait NA relational demography score separately as the predictor variable for affective diversity when examining the CEO's participative decision-making style. The mean trait NA

relational demography score for the CEOs was 1.34 Is.d. = .66). We used the standard deviation of the top management team's trait NA to measure negative affective diversity (x = 1.03, s.d. = .38).

Mean level trait negative affect. We calculated group-level trait negative affect as the average of the team members' trait NA scores, including the CEO (x = 2.81, s.d. = 52). For individual-level analyses, we calculated a variable to control for the trait NA of the other members of the team. This variable represents the mean trait NA of everyone minus the self (x = 2.79, s.d. = 1.06).

Perceived group negative affective culture. To control for perceptual biases in the individual-level analyses, we measured top management team members' (not including the CEO) perceptions of the negative affective culture in their top management team by having them rate the following items: "The emotional culture of our top management team is nervous, irritable, and distressed," and "The emotional culture of our top management team is calm and serene" (reverse coded). A perceived team negative culture score was calculated for each top management team member by taking his or her mean rating on both items (scored on a 7-point Likert scale; 1 = Strongly Disagree through 7 = Strongly Agree). The mean perceived team negative culture score was 3.59 (s.d. = 1.37), and the Cronbach alpha reliability was .64.

APPENDIX B: CEO Participative Leadership Scale

Our CEO participative-leadership-style scale measured each CEO's degree of participativeness versus autocracy as rated by their top management teams. Top management team members were asked about the degree of participativeness of their CEO when dealing with the following 17 organizational issues: acquisition of major capital, change in resource allocation processes, allocation of capital, changes in operating budgets, corporate **financing**, corporate relocations or locations of new plants/offices, human resource strategy, corporate acquisitions, addition of a product line, deletion of a product line, emphases of particular product lines, marketing strategy, overall strategic direction, hiring members of the TMT, firing members of the TMT, international expansion, and changes to the organizational structure. Senior managers rated CEO

participativeness on a 5-point response scale adapted from Heller (1971): 1 = CEO makes the decision alone without a detailed explanation to the TMT; 2 = CEO makes the decision alone with a detailed explanation to the TMT; 3 = CEO consults with the TMT and then makes the decision, which may or may not concur with the recommendations made by the TMT; 4 = there is joint decision making between the CEO and the TMT, the entire team, including the CEO, reaches consensus, and the team's decision is implemented; and 5 = the CEO delegates the decision-making responsibility to the top management team. We calculated the final CEO participative style decision-making score by recoding the five responses using the weighted scale (recoded as 0, 1, 5, 8, and 10, respectively) as recommended by Vroom and Yetton (1973), calculating the mean of the weighted 17 items for each senior manager's assessment of his or her CEO (Cronbach alpha = .90) and then aggregating the ratings across the senior management team to form a group-level score for each CEO (x = 5.90, s.d. = 1.18).

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Geographic Names: United States; US

Descriptors: Management styles; Psychological aspects; Organizational behavior; Studies; Teamwork
Classification Codes: 2500 (CN=Organizational behavior); 9130 (CN=Experimental/Theoretical); 2200 (CN=Managerial skills); 9190 (CN=United States)
Print Media ID: 24671

30/9/4 (Item 4 from file: 15)
02122550 68561056
Notes on current labor statistics

Anonymous
Monthly Labor Review v123n12 pp: 44-53
Dec 2000
CODEN: MLARAO
ISSN: 0098-1818 Journal Code: MLR
Document Type: Periodical; Statistics Language: English Record Type: Fulltext Length: 10 Pages
Word Count: 10216

Abstract:

This article presents the principal statistical series collected and calculated by the Bureau of Labor Statistics: series on labor force; employment; unemployment; labor compensation; consumer, producer, and international prices; productivity; international comparisons; and injury and illness statistics. The data in each group of tables are briefly described.

Text:

This section of the Review presents the principal statistical series collected and calculated by the Bureau of Labor Statistics: series on labor force; employment; unemployment; labor compensation; consumer, producer, and international prices; productivity; international comparisons; and injury and illness statistics. In the notes that follow, the data in each group of tables are briefly described; key definitions are given; notes on the data are set forth; and sources of additional information are cited.

General notes

The following notes apply to several tables in this section:

Seasonal adjustment. Certain monthly and quarterly data are adjusted to eliminate the effect on the data of such factors as climatic conditions, industry production schedules, opening and closing of schools, holiday buying periods, and vacation practices, which might prevent short-term evaluation of the statistical series. Tables containing data that have been adjusted are identified as "seasonally adjusted." (All other data are not seasonally adjusted.) Seasonal effects are estimated on the basis of past experience. When new seasonal factors are computed each year, revisions may affect seasonally adjusted data for several preceding years.

Seasonally adjusted data appear in tables 1- 14, 16-17, 39, and 43. Seasonally adjusted labor force data in tables I and 4-9 were revised in the February 2000 issue of the Review. Seasonally adjusted establishment survey data shown in tables 1, 12-14 and 1617 were revised in the July 2000 Review and reflect the experience through March 2000. A brief explanation of the seasonal adjustment methodology appears in "Notes on the data."

Revisions in the productivity data in table 45 are usually introduced in the September issue. Seasonally adjusted indexes and percent changes from month-to-month and quarter-to-quarter are published for numerous Consumer and Producer Price Index series. However, seasonally adjusted indexes are not published for the U.S. average All-- Items CPI. Only seasonally adjusted percent changes are available for this series.

Adjustments for price changes. Some data-such as the "real" earnings shown in table 14-are adjusted to eliminate the effect of changes in price. These adjustments are made by dividing current-dollar values by the Consumer Price Index or the appropriate component of the index, then multiplying by 100. For example, given a current hourly wage rate of $3 and a current price index number of 150, where 1982 = 100, the hourly rate expressed in 1982 dollars is $2 ($3/150 x 100 = $2). The $2 (or any other resulting values) are described as "real," "constant," or "1982" dollars.

Sources of information

Data that supplement the tables in this section are published by the Bureau in a variety of sources. Definitions of each series and notes on the data are contained in later sections of these Notes describing each set of data. For detailed descriptions of each data series, see BLs Handbook of Methods, Bulletin 2490. Users also may wish to consult Major Programs of the Bureau of Labor Statistics, Report 919. News releases provide the latest statistical information published by the Bureau; the major recurring releases are published according to the schedule appearing on the back cover of this issue.

More information about labor force, employment, and unemployment data and the household and establishment surveys underlying the data are available in the Bureau's monthly publication, Employment and Earnings. **Historical** unadjusted and seasonally adjusted data from the household survey are available on the Internet:

http://stats.bls.gov/cpshome.htm

Historically comparable unadjusted and seasonally adjusted data from the establishment survey also are available on the Internet:

http://stats.bls.gov/ceshome.htm

Additional information on labor force data for areas below the national level are provided in the BLS annual report, Geographic Profile of Employment and Unemployment.

For a comprehensive discussion of the Employment Cost Index, see Employment Cost Indexes and Levels, 1975-95, BLS Bulletin 2466. The most recent data from the Employee Benefits Survey appear in the following Bureau of Labor Statistics bulletins: Employee Benefits in Medium and Large Firms; Employee Benefits in Small Private Establishments; and Employee Benefits in State and Local Governments.

More detailed data on consumer and producer prices are published in the monthly periodicals, The CPI Detailed Report and Producer Price Indexes. For an overview of the 1998 revision of the cPi, see the December 1996 issue of the Monthly Labor Review. Additional data on international prices appear in monthly news releases.

Listings of industries for which productivity indexes are available may be found on the Internet:

http://stats.bls.gov/iprhome.htm

For additional information on international comparisons data, see International Comparisons of Unemployment, BLS Bulletin 1979.

Detailed data on the occupational injury and illness series are published in Occupational Injuries and Illnesses in the United States, by Industry, a Us annual bulletin.
Finally, the Monthly Labor Review carries analytical articles on annual and longer term developments in labor force, employment, and unemployment; employee compensation and collective bargaining; prices; productivity; international comparisons; and injury and illness data.

Symbols

n.e.c. = not elsewhere classified.

n.e.s. = not elsewhere specified.

p = preliminary. To increase the timeliness of some series, preliminary figures are issued based on representative but incomplete returns.

r = revised. Generally, this revision reflects the availability of later data, but also may reflect other adjustments.

Comparative Indicators

(Tables 1-3)

Comparative indicators tables provide an overview and comparison of major BLS statistical series. Consequently, although many of the included series are available monthly, all measures in these comparative tables are presented quarterly and annually.

Labor market indicators include employment measures from two major surveys and information on rates of change in compensation provided by the Employment Cost Index (ECI) program. The labor force participation rate, the employment-to-population ratio, and unemployment rates for major demographic groups based on the Current Population ("household") Survey are presented, while measures of employment and average weekly hours by major industry sector are given using nonfarm payroll data. The Employment Cost Index (compensation), by major sector and by bargaining status, is chosen from a variety of BLS compensation and wage measures because it provides a comprehensive measure of employer costs for hiring labor, not just outlays for wages, and it is not affected by employment shifts among occupations and industries.

Data on changes in compensation, prices, and productivity are presented in table 2. Measures of rates of change of compensation and wages from the Employment Cost Index program are provided for all civilian nonfarm workers (excluding Federal and household workers) and for all private nonfarm workers. Measures of changes in consumer prices for all urban consumers; producer prices by stage of processing; overall prices by stage of processing; and overall export and import price indexes are given. Measures of productivity (output per hour of all persons) are provided for major sectors.
Alternative measures of wage and compensation rates of change, which reflect the overall trend in labor costs, are summarized in table 3. Differences in concepts and scope, related to the specific purposes of the series, contribute to the variation in changes among the individual measures.

Notes on the data

Definitions of each series and notes on the data are contained in later sections of these notes describing each set of data.

Employment and Unemployment Data

(Tables 1; 4-20)

Household survey data

Description of the series

EMPLOYMENT DATA in this section are obtained from the Current Population Survey, a program of personal interviews conducted monthly by the Bureau of the Census for the Bureau of Labor Statistics. The sample consists of about 50,000 households selected to represent the U.S. population 16 years of age and older. Households are interviewed on a rotating basis, so that three-fourths of the sample is the same for any 2 consecutive months.

Definitions

Employed persons include (1) all those who worked for pay any time during the week which includes the 12th day of the month or who worked unpaid for 15 hours or more in a family-operated enterprise and (2) those who were temporarily absent from their regular jobs because of illness, vacation, industrial dispute, or similar reasons. A person working at more than one job is counted only in the job at which he or she worked the greatest number of hours.

Unemployed persons are those who did not work during the survey week, but were available for work except for temporary illness and had looked for jobs within the preceding 4 weeks. Persons who did not look for work because they were on layoff are also counted among the unemployed. The

unemployment rate represents the number unemployed as a percent of the civilian labor force.

The civilian labor force consists of all employed or unemployed persons in the civilian noninstitutional population. Persons not in the labor force are those not classified as employed or unemployed. This group includes discouraged workers, defined as persons who want and are available for a job and who have looked for work sometime in the past 12 months (or since the end of their last job if they held one within the past 12 months), but are not currently looking, because they believe there are no jobs available or there are none for which they would qualify. The civilian noninstitutional population comprises all persons 16 years of age and older who are not inmates of penal or mental institutions, sanitariums, or homes for the aged, infirm, or needy. The civilian labor force participation rate is the proportion of the civilian noninstitutional population that is in the labor force. The employment-population ratio is employment as a percent of the civilian noninstitutional population.

Notes on the data

From time to time, and especially after a decennial census, adjustments are made in the Current Population Survey figures to correct for estimating errors during the intercensal years. These adjustments affect the comparability of **historical** data. A description of these adjustments and their effect on the various data series appears in the Explanatory Notes of Employment and Earnings.

Data beginning in 2000 are not strictly comparable with data for 1999 and earlier years because of the introduction of revised population controls. Additional information appears in the February 2000 issue of Employment and Earnings.
Labor force data in tables 1 and 4-9 are seasonally adjusted. Since January 1980, national labor force data have been seasonally adjusted with a procedure called X-11 ARIMA which was developed at Statistics Canada as an extension of the standard X11 method previously used by BLS. A detailed description of the procedure appears in the X- 11 ARIMA Seasonal Adjustment Method, by Estela Bee Dagum (Statistics Canada, Catalogue No. 12-564E, January 1983).

At the beginning of each calendar year, **historical** seasonally adjusted data usually are revised, and projected seasonal adjustment factors are calculated for use during the January-June period. The **historical** seasonally adjusted data usually are revised for only the most recent 5 years. In July, new seasonal adjustment factors, which incorporate the experience through June, are produced for the July-December period, but no revisions are made in the **historical** data.

FOR ADDITIONAL INFORMATION on national household survey data, contact the Division of Labor Force Statistics: (202) 691-- 6378.

Establishment survey data

Description of the series

EMPLOYMENT, HOURS, AND EARNINGS DATA in this section are compiled from payroll records reported monthly on a voluntary basis to the Bureau of Labor Statistics and its cooperating State agencies by about 300,000 establishments representing all industries except agriculture. Industries are classified in accordance with the 1987 Standard Industrial Classification (sic) Manual. In most industries, the sampling probabilities are based on the size of the establishment; most large establishments are therefore in the sample. (An establishment is not necessarily a firm; it

may be a branch plant, for example, or warehouse.) Self-employed persons and others not on a regular civilian payroll are outside the scope of the survey because they are excluded from establishment records. This largely accounts for the difference in employment figures between the household and establishment surveys.

Definitions

An establishment is an economic unit which produces goods or services (such as a factory or store) at a single location and is engaged in one type of economic activity.

Employed persons are all persons who received pay (including holiday and sick pay) for any part of the payroll period including the 12th day of the month. Persons holding more than one job (about 5 percent of all persons in the labor force) are counted in each establishment which reports them. Production workers in manufacturing include working supervisors and nonsupervisory workers closely associated with production operations. Those workers mentioned in tables 11-16 include production workers in manufacturing and mining; construction workers in construction; and nonsupervisory workers in the following industries: transportation and public utilities; wholesale and retail trade; **finance**, insurance, and real estate; and services. These groups account for about four-fifths of the total employment on private nonagricultural payrolls.

Earnings are the payments production or nonsupervisory workers receive during the survey period, including premium pay for overtime or late-shift work but excluding irregular bonuses and other special payments. Real earnings are earnings adjusted to reflect the effects of changes in consumer prices. The deflator for this series is derived from the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W).

Hours represent the average weekly hours of production or nonsupervisory workers for which pay was received, and are different from standard or scheduled hours. Overtime hours represent the portion of average weekly hours which was in excess of regular hours and for which overtime premiums were paid.

The Diffusion Index represents the percent of industries in which employment was rising over the indicated period, plus one-half of the industries with unchanged employment; 50 percent indicates an equal balance between industries with increasing and decreasing employment. In line with Bureau practice, data for the 1-, 3-, and 6-month spans are seasonally adjusted, while those for the 12-month span are unadjusted. Data are centered within the span. Table 17 provides an index on private nonfarm employment based on 356 industries, and a manufacturing index based on 139 industries. These indexes are useful for measuring the dispersion of economic gains or losses and are also economic indicators.

Notes on the data

Establishment survey data are annually adjusted to comprehensive counts of employment (called "benchmarks"). The latest adjustment, which incorporated March 1999 benchmarks, was made with the release of May 2000 data, published in the July 2000 issue of the Review. Coincident with the benchmark adjustment, **historical** seasonally adjusted data were revised to reflect updated seasonal factors. Unadjusted data from April 1999 forward and seasonally adjusted data from January 1996 forward are subject to revision in future benchmarks.

In addition to the routine benchmark revisions and updated seasonal factors introduced with the release of the May 2000 data, all estimates for the

wholesale trade division from April 1998 forward were revised to incorporate a new sample design. This represented the first major industry division to convert to a probability-based sample under a 4-year phase-in plan for the establishment survey sample redesign project. For additional information, see the the June 2000 issue of Employment and Earnings.

Revisions in State data (table 11) occurred with the publication of January 2000 data.

Beginning in June 1996, the BLS uses the X-12 ARIMA methodology to seasonally adjust establishment survey data. This procedure, developed by the Bureau of the Census, controls for the effect of varying survey **intervals** (also known as the 4- versus 5-week effect), thereby providing improved measurement of over-the-month changes and underlying economic trends. Revisions of data, usually for the most recent 5-year period, are made once a year coincident with the benchmark revisions.

In the establishment survey, estimates for the most recent 2 months are based on incomplete returns and are published as preliminary in the tables (12-17 in the Review). When all returns have been received, the estimates are revised and published as "final" (prior to any benchmark revisions) in the third month of their appearance. Thus, December data are published as preliminary in January and February and as final in March. For the same reasons, quarterly establishment data (table 1) are preliminary for the first 2 months of publication and final in the third month. Thus, fourth-quarter data are published as preliminary in January and February and as final in March.

FOR ADDITIONAL INFORMATION on establishment survey data, contact the Division of Monthly Industry Employment Statistics: (202) 691-6555.

Unemployment data by State

Description of the series

Data presented in this section are obtained from the Local Area Unemployment Statistics (LAus) program, which is conducted in cooperation with State employment security agencies.

Monthly estimates of the labor force, employment, and unemployment for States and sub-State areas are a key indicator of local economic conditions, and form the basis for determining the eligibility of an area for benefits under Federal economic assistance programs such as the Job Training Partnership Act. Seasonally adjusted unemployment rates are presented in table 10. Insofar as possible, the concepts and definitions underlying these data are those used in the national estimates obtained from theCPS

Notes on the data
Data refer to State of residence. Monthly data for all States and the District of Columbia are derived using standardized procedures established by BLs. Once a year, estimates are revised to new population controls, usually with publication of January estimates, and benchmarked to annual average cps levels.

FOR ADDITIONAL INFORMATION on data in this series, call (202) 691-6392 (table 10) or (202) 691-6559 (table 11).

Compensation and Wage Data

(Tables 1-3; 21-27)

COMPENSATION AND WAGE DATA are gathered by the Bureau from business establishments, State and local governments, labor unions, collective bargaining agreements on file with the Bureau, and secondary sources.

Employment Cost Index

Description of the series

The Employment Cost Index (ECI) is a quarterly measure of the rate of change in compensation per hour worked and includes wages, salaries, and employer costs of employee benefits. It uses a fixed market basket of labor-similar in concept to the Consumer Price Index's fixed market basket of goods and services-to measure change over time in employer costs of employing labor.

Statistical series on total compensation costs, on wages and salaries, and on benefit costs are available for private nonfarm workers excluding proprietors, the self-employed, and household workers. The total compensation costs and wages and salaries series are also available for State and local government workers and for the civilian nonfarm economy, which consists of private industry and State and local government workers combined. Federal workers are excluded.

The Employment Cost Index probability sample consists of about 4,400 private nonfarm establishments providing about 23,000 occupational observations and 1,000 State and local government establishments providing 6,000 occupational observations selected to represent total employment in each sector. On average, each reporting unit provides wage and compensation information on five well-specified occupations. Data are collected each quarter for the pay period including the 12th day of March, June, September, and December.

Beginning with June 1986 data, fixed employment weights from the 1980 Census of Population are used each quarter to calculate the civilian and private indexes and the index for State and local governments. (Prior to June 1986, the employment weights are from the 1970 Census of Population.) These fixed weights, also used to derive all of the industry and occupation series indexes, ensure that changes in these indexes reflect only changes in compensation, not employment shifts among industries or occupations with different levels of wages and compensation. For the bargaining status, region, and metropolitan/non-metropolitan area series, however, employment data by industry and occupation are not available from the census. Instead, the 1980 employment weights are reallocated within these series each quarter based on the current sample. Therefore, these indexes are not strictly comparable to those for the aggregate, industry, and occupation series.

Definitions

Total compensation costs include wages, salaries, and the employer's costs for employee benefits.

Wages and salaries consist of earnings before payroll deductions, including production bonuses, incentive earnings, commissions, and cost-of-living adjustments.

Benefits include the cost to employers for paid leave, supplemental pay (including nonproduction bonuses), insurance, retirement and savings plans, and legally required benefits (such as Social Security, workers' compensation, and unemployment insurance).

Excluded from wages and salaries and employee benefits are such items as

payment-inkind, free room and board, and tips.

Notes on the data

The Employment Cost Index for changes in wages and salaries in the private nonfarm economy was published beginning in 1975. Changes in total compensation cost-wages and salaries and benefits combined-were published beginning in 1980. The series of changes in wages and salaries and for total compensation in the State and local government sector and in the civilian nonfarm economy (excluding Federal employees) were published beginning in 1981. **Historical** indexes (June 1981=100) are available on the Internet:

http://stats.bls.gov/ecthome.htm

FOR ADDITIONAL INFORMATION on the Employment Cost Index, contact the Office of Compensation Levels and Trends: (202) 691-6199.

Employee Benefits Survey

Description of the series
Employee benefits data are obtained from the Employee Benefits Survey, an annual survey of the incidence and provisions of selected benefits provided by employers. The survey collects data from a sample of approximately 9,000 private sector and State and local government establishments. The data are presented as a percentage of employees who participate in a certain benefit, or as an average benefit provision (for example, the average number of paid holidays provided to employees per year). Selected data from the survey are presented in table 25 for medium and large private establishments and in table 26 for small private establishments and State and local government.

The survey covers paid leave benefits such as holidays and vacations, and personal, funeral, jury duty, military, family, and sick leave; short-term disability, long-term disability, and life insurance; medical, dental, and vision care plans; defined benefit and defined contribution plans; flexible benefits plans; reimbursement accounts; and unpaid family leave.

Also, data are tabulated on the incidence of several other benefits, such as severance pay, child-care assistance, wellness programs, and employee assistance programs.

Definitions

Employer-provided benefits are benefits that are **financed** either wholly or partly by the employer. They may be sponsored by a union or other third party, as long as there is some employer **financing**.
However, some benefits that are fully paid for by the employee also are included. For example, longterm care insurance and postretirement life insurance paid entirely by the employee are included because the guarantee of insurability and availability at group premium rates are considered a benefit.

Participants are workers who are covered by a benefit, whether or not they use that benefit. If the benefit plan is **financed** wholly by employers and requires employees to complete a minimum length of service for eligibility, the workers are considered participants whether or not they have met the requirement. If workers are required to contribute towards the cost of a plan, they are considered participants only if they elect the plan and agree to make the required contributions.

Defined benefit pension plans use predetermined formulas to calculate a

retirement benefit (if any), and obligate the employer to provide those benefits. Benefits are generally based on salary, years of service, or both.

Defined contribution plans generally specify the level of employer and employee contributions to a plan, but not the formula for determining eventual benefits. Instead, individual accounts are set up for participants, and benefits are based on amounts credited to these accounts.

Tax-deferred savings plans are a type of defined contribution plan that allow participants to contribute a portion of their salary to an employer-sponsored plan and defer income taxes until withdrawal.

Flexible benefit plans allow employees to choose among several benefits, such as life insurance, medical care, and vacation days, and among several levels of coverage within a given benefit.

Notes on the data

Surveys of employees in medium and large establishments conducted over the 1979-86 period included establishments that employed at least 50, 100, or 250 workers, depending on the industry (most service industries were excluded). The survey conducted in 1987 covered only State and local governments with 50 or more employees. The surveys conducted in 1988 and 1989 included medium and large establishments with 100 workers or more in private industries. All surveys conducted over the 1979-89 period excluded establishments in Alaska and Hawaii, as well as part-time employees.

Beginning in 1990, surveys of State and local governments and small private establishments were conducted in evennumbered years, and surveys of medium and large establishments were conducted in oddnumbered years. The small establishment survey includes all private nonfarm establishments with fewer than 100 workers, while the State and local government survey includes all governments, regardless of the number of workers. All three surveys include full- and part-time workers, and workers in all 50 States and the District of Columbia.

FOR ADDITIONAL INFORMATION on the Employee Benefits Survey, contact the Office of Compensation Levels and Trends on the Internet:

http://stats.bls.gov/ebshome.htm

Work stoppages

Description of the series

Data on work stoppages measure the number and duration of major strikes or lockouts (involving 1,000 workers or more) occurring during the month (or year), the number of workers involved, and the amount of work time lost because of stoppage. These data are presented in table 27.

Data are largely from a variety of published sources and cover only establishments directly involved in a stoppage. They do not measure the indirect or secondary effect of stoppages on other establishments whose employees are idle owing to material shortages or lack of service.

Definitions

Number of stoppages: The number of strikes and lockouts involving 1,000 workers or more and lasting a full shift or longer.

Workers involved: The number of workers directly involved in the stoppage.

Number of days idle: The aggregate number of workdays lost by workers involved in the stoppages.

Days of as a percent of estimated working time: Aggregate workdays lost as a percent of the aggregate number of standard workdays in the period multiplied by total employment in the period.

Notes on the data

This series is not comparable with the one terminated in 1981 that covered strikes involving six workers or more.

FOR ADDITIONAL INFORMATION on work stoppages data, contact the Office of Compensation and Working Conditions: (202) 691-6282, or the Internet:

http://stats.bls.gov/cbahome.htm
Price Data

(Tables 2; 28-38)

PRICE DATA are gathered by the Bureau of Labor Statistics from retail and primary markets in the United States. Price indexes are given in relation to a base period-1982 =100 for many Producer Price Indexes, 1982-84 = 100 for many Consumer Price Indexes (unless otherwise noted), and 1990 = 100 for International Price Indexes.

Consumer Price Indexes

Description of the series

The Consumer Price Index (CPI) is a measure of the average change in the prices paid by urban consumers for a fixed market basket of goods and services. The CPI is calculated monthly for two population groups, one consisting only of urban households whose primary source of income is derived from the employment of wage earners and clerical workers, and the other consisting of all urban households. The wage earner index (cPIw) is a continuation of the historic index that was introduced well over a half-century ago for use in wage negotiations. As new uses were developed for the cPi in recent years, the need for a broader and more representative index became apparent. The all-urban consumer index (CPI-u), introduced in 1978, is representative of the 1993-95 buying habits of about 87 percent of the noninstitutional population of the United States at that time, compared with 32 percent represented in the cpi-w. In addition to wage earners and clerical workers, the cPi-u covers professional, managerial, and technical workers, the selfemployed, short-term workers, the unemployed, retirees, and others not in the labor force.

The CPI is based on prices of food, clothing, shelter, fuel, drugs, transportation fares, doctors' and dentists' fees, and other goods and services that people buy for day-to-day living. The quantity and quality of these items are kept essentially unchanged between major revisions so that only price changes will be measured. All taxes directly associated with the purchase and use of items are included in the index.

Data collected from more than 23,000 retail establishments and 5,800 housing units in 87 urban areas across the country are used to develop the "U.S. city average." Separate estimates for 14 major urban centers are presented in table 29. The areas listed are as indicated in footnote 1 to the table. The area indexes measure only the average change in prices for each area since the base period, and do not indicate differences in the level of prices among cities.

Notes on the data
In January 1983, the Bureau changed the way in which homeownership costs are meaured for the cpi-u. A rental equivalence method replaced the asset-price approach to homeownership costs for that series. In January 1985, the same change was made in the cpi-w. The central purpose of the change was to separate shelter costs from the investment component of home-ownership so that the index would reflect only the cost of shelter services provided by owneroccupied homes. An updated cpi-u and cpiw were introduced with release of the January 1987 and January 1998 data.

FOR ADDITIONAL INFORMATION on consumer prices, contact the Division of Consumer Prices and Price Indexes: (202) 691-7000.

Producer Price Indexes

Description of the series

Producer Price Indexes (PPI) measure average changes in prices received by domestic producers of commodities in all stages of processing. The sample used for calculating these indexes currently contains about 3,200 commodities and about 80,000 quotations per month, selected to represent the movement of prices of all commodities produced in the manufacturing; agriculture, forestry, and fishing; mining; and gas and electricity and public utilities sectors. The stage-- of-processing structure of PPi organizes products by class of buyer and degree of fabrication (that is, finished goods, intermediate goods, and crude materials). The traditional commodity structure of Ppi organizes products by similarity of end use or material composition. The industry and product structure of PPI organizes data in accordance with the Standard Industrial Classification (sic) and the product code extension of the sic developed by the U.S. Bureau of the Census.

To the extent possible, prices used in calculating Producer Price Indexes apply to the first significant commercial transaction in the United States from the production or central marketing point. Price data are generally collected monthly, primarily by mail questionnaire. Most prices are obtained directly from producing companies on a voluntary and confidential basis. Prices generally are reported for the Tuesday of the week containing the 13th day of the month.

Since January 1992, price changes for the various commodities have been averaged together with implicit quantity weights representing their importance in the total net selling **value** of all commodities as of 1987. The detailed data are aggregated to obtain indexes for stage-of-processing groupings, commodity groupings, durability-of-product groupings, and a number of special composite groups. All Producer Price Index data are subject to revision 4 months after original publication.

FOR ADDITIONAL INFORMATION on producer prices, contact the Division of Industrial Prices and Price Indexes: (202) 691-7705.

International Price Indexes

Description of the series

The International Price Program produces monthly and quarterly export and import price indexes for nonmilitary goods traded between the United States and the rest of the world. The export price index provides a measure of price change for all products sold by U.S. residents to foreign buyers. ("Residents" is defined as in the national income accounts; it includes corporations, businesses, and individuals, but does not require the organizations to be U.S. owned nor the individuals to have U.S.

citizenship.) The import price index provides a measure of price change for goods purchased from other countries by U.S. residents.

The product universe for both the import and export indexes includes raw materials, agricultural products, semifinished manufactures, and finished manufactures, including both capital and consumer goods. Price data for these items are collected primarily by mail questionnaire. In nearly all cases, the data are collected directly from the exporter or importer, although in a few cases, prices are obtained from other sources.

To the extent possible, the data gathered refer to prices at the U.S. border for exports and at either the foreign border or the U.S. border for imports. For nearly all products, the prices refer to transactions completed during the first week of the month. Survey respondents are asked to indicate all discounts, allowances, and rebates applicable to the reported prices, so that the price used in the calculation of the indexes is the actual price for which the product was bought or sold.

In addition to general indexes of prices for U.S. exports and imports, indexes are also published for detailed product categories of exports and imports. These categories are defined according to the five-digit level of detail for the Bureau of Economic **Analysis** End-use Classification (sTTC), and the fourdigit level of detail for the Harmonized System. Aggregate import indexes by country or region of origin are also available.

BLS publishes indexes for selected categories of internationally traded services, calculated on an international basis and on a balance-of-payments basis.

Notes on the data

The export and import price indexes are weighted indexes of the Laspeyres type. Price relatives are assigned equal importance within each harmonized group and are then aggregated to the higher level. The values assigned to each weight category are based on trade **value** figures compiled by the Bureau of the Census. The trade weights currently used to compute both indexes relate to 1990.

Because a price index depends on the same items being priced from period to period, it is necessary to recognize when a product's specifications or terms of transaction have been modified. For this reason, the Bureau's questionnaire requests detailed descriptions of the physical and functional characteristics of the products being priced, as well as information on the number of units bought or sold, discounts, credit terms, packaging, class of buyer or seller, and so forth. When there are changes in either the specifications or terms of transaction of a product, the dollar **value** of each change is deleted from the total price change to obtain the "pure" change. Once this **value** is determined, a linking procedure is employed which allows for the continued repricing of the item.

For the export price indexes, the preferred pricing is f.a.s. (free alongside ship) U.S. port of exportation. When firms report export prices f.o.b. (free on board), production point information is collected which enables the Bureau to calculate a shipment cost to the port of exportation. An attempt is made to collect two prices for imports. The first is the import price fo.b. at the foreign port of exportation, which is consistent with the basis for **valuation** of imports in the national accounts. The second is the import price c.i.f.(costs, insurance, and freight) at the U.S. port of importation, which also includes the other costs associated with bringing the product to the U.S. border. It does not,

however, include duty charges. For a given product, only one price basis series is used in the construction of an index.

FOR ADDITIONAL INFORMATION on international prices, contact the Division of International Prices (202) 691-7155.

Productivity Data

(Tables 2; 39-42)

Business sector and major sectors

Description of the series

The productivity measures relate real output to real input. As such, they encompass a family of measures which include single-factor input measures, such as output per hour, output per unit of labor input, or output per unit of capital input, as well as measures of multifactor productivity (output per unit of combined labor and capital inputs). The Bureau indexes show the change in output relative to changes in the various inputs. The measures cover the business, nonfarm business, manufacturing, and nonfinancial corporate sectors.

Corresponding indexes of hourly compensation, unit labor costs, unit nonlabor payments, and prices are also provided.

Definitions

Output per hour of all persons (labor productivity) is the quantity of goods and services produced per hour of labor input. Output per unit of capital services (capital productivity) is the quantity of goods and services produced per unit of capital services input. Multifactor productivity is the quantity of goods and services produced per combined inputs. For private business and private nonfarm business, inputs include labor and capital units. For manufacturing, inputs include labor, capital, energy, non-energy materials, and purchased business services.

Compensation per hour is total compensation divided by hours at work. Total compensation equals the wages and salaries of employees plus employers' contributions for social insurance and private benefit plans, plus an estimate of these payments for the self-employed (except for nonfinancial corporations in which there are no self-employed). Real compensation per hour is compensation per hour deflated by the change in the Consumer Price Index for All Urban Consumers.
Unit labor costs are the labor compensation costs expended in the production of a unit of output and are derived by dividing compensation by output. Unit nonlabor payments include profits, depreciation, interest, and indirect taxes per unit of output. They are computed by subtracting compensation of all persons from current-dollar **value** of output and dividing by output.

Unit nonlabor costs contain all the components of unit nonlabor payments except unit profits.

Unit profits include corporate profits with inventory **valuation** and capital consumption adjustments per unit of output.

Hours of all persons are the total hours at work of payroll workers, self-employed persons, and unpaid family workers.

Labor inputs are hours of all persons adjusted for the effects of changes in the education and experience of the labor force.

Capital services are the flow of services from the capital stock used in production. It is developed from measures of the net stock of physical assets–equipment, structures, land, and inventories–weighted by rental prices for each type of asset.
Combined units of labor and capital inputs are derived by combining changes in labor and capital input with weights which represent each component's share of total cost. Combined units of labor, capital, energy, materials, and purchased business services are similarly derived by combining changes in each input with weights that represent each input's share of total costs. The indexes for each input and for combined units are based on changing weights which are averages of the shares in the current and preceding year (the Tornquist index-number formula).

Notes on the data

Business sector output is an annually-weighted index constructed by excluding from real gross domestic product (GDP) the following outputs: general government, nonprofit institutions, paid employees of private households, and the rental **value** of owner-occupied dwellings.
Nonfarm business also excludes farming. Private business and private nonfarm business further exclude government enterprises. The measures are supplied by the U.S. Department of Commerce's Bureau of Economic **Analysis**. Annual estimates of manufacturing sectoral output are produced by the Bureau of Labor Statistics. Quarterly manufacturing output indexes from the Federal Reserve Board are adjusted to these annual output measures by the BLS. Compensation data are developed from data of the Bureau of Economic **Analysis** and the Bureau of Labor Statistics.
Hours data are developed from data of the Bureau of Labor Statistics.
The productivity and associated cost measures in tables 39–42 describe the relationship between output in real terms and the labor and capital inputs involved in its production. They show the changes from period to period in the amount of goods and services produced per unit of input.

Although these measures relate output to hours and capital services, they do not measure the contributions of labor, capital, or any other specific factor of production. Rather, they reflect the joint effect of many influences, including changes in technology; shifts in the composition of the labor force; capital investment; level of output; changes in the utilization of capacity, energy, material, and research and development; the organization of production; managerial skill; and characteristics and efforts of the work force.

FOR ADDITIONAL INFORMATION on this productivity series, contact the Division of Productivity Research: (202) 691-5606.

Industry productivity measures

Description of the series

The BLS industry productivity data supplement the measures for the business economy and major sectors with annual measures of labor productivity for selected industries at the three- and four-digit levels of the Standard Industrial Classification system. In addition to labor productivity, the industry data also include annual measures of compensation and unit labor costs for three-digit industries and measures of multifactor productivity for three-digit manufacturing industries and railroad transportation. The industry measures differ in methodology and data sources from the productivity measures for the major sectors because the industry measures are developed independently of the National Income and Product Accounts framework used for the major sector measures.

Definitions

Output per hour is derived by dividing an index of industry output by an index of labor input. For most industries, output indexes are derived from data on the **value** of industry output adjusted for price change.
For the remaining industries, output indexes are derived from data on the physical quantity of production.

The labor input series consist of the hours of all employees (production workers and nonproduction workers), the hours of all persons (paid employees, partners, proprietors, and unpaid family workers), or the number of employees, depending upon the industry.

Unit labor costs represent the labor compensation costs per unit of output produced, and are derived by dividing an index of labor compensation by an index of output. Labor compensation includes payroll as well as supplemental payments, including both legally required expenditures and payments for voluntary programs.

Multifactor productivity is derived by dividing an index of industry output by an index of the combined inputs consumed in producing that output. Combined inputs include capital, labor, and intermediate purchases. The measure of capital input used represents the flow of services from the capital stock used in production. It is developed from measures of the net stock of physical assets-equipment, structures, land, and inventories. The measure of intermediate purchases is a combination of purchased materials, services, fuels, and electricity.

Notes on the data

The industry measures are compiled from data produced by the Bureau of Labor Statistics and the Bureau of the Census,with additional data supplied by other government agencies, trade associations, and other sources.

For most industries, the productivity indexes refer to the output per hour of all employees. For some trade and services industries, indexes of output per hour of all persons (including self-employed) are constructed. For some transportation industries, only indexes of output per employee are prepared.
FOR ADDITIONAL INFORMATION on this series, contact the Division of Industry Productivity Studies: (202) 691-5618.

International Comparisons

(Tables 43--45)

Labor force and unemployment

Description of the series

Tables 43 and 44 present comparative measures of the labor force, employment, and unemployment-approximating U.S. concepts-for the United States, Canada, Australia, Japan, and several European countries. The unemployment statistics (and, to a lesser extent, employment statistics) published by other industrial countries are not, in most cases, comparable to U.S. unemployment statistics. Therefore, the Bureau adjusts the figures for selected countries, where necessary, for all known major definitional differences. Although precise comparability may not be achieved, these adjusted figures provide a better basis for international comparisons than the figures regularly published by each country.

Definitions

For the principal U.S. definitions of the labor force, employment, and unemployment, see the Notes section on Employment and Unemployment Data: Household survey data.

Notes on the data

The adjusted statistics have been adapted to the age at which compulsory schooling ends in each country, rather than to the U.S. standard of 16 years of age and older. Therefore, the adjusted statistics relate to the population aged 16 and older in France, Sweden, and the United Kingdom; 15 and older in Canada, Australia, Japan, Germany, Italy from 1993 onward, and the Netherlands; and 14 and older in Italy prior to 1993. The institutional population is included in the denominator of the labor force participation rates and employment-population ratios for Japan and Germany; it is excluded for the United States and the other countries.

In the U.S. labor force survey, persons on layoff who are awaiting recall to their jobs are classified as unemployed. European and Japanese layoff practices are quite different in nature from those in the United States; therefore, strict application of the U.S. definition has not been made on this point. For further information, see Monthly Labor Review, December 1981, pp. 8-11.

The figures for one or more recent years for France, Germany, Italy, the Netherlands, and the United Kingdom are calculated using adjustment factors based on labor force surveys for earlier years and are considered preliminary. The recent-year measures for these countries, therefore, are subject to revision whenever data from more current labor force surveys become available.

There are breaks in the data series for the United States (1990, 1994, 1997, 1998), France (1992), Italy (1991, 1993), the Netherlands (1988), and Sweden (1987).

For the United States, the break in series reflects a major redesign of the labor force survey questionnaire and collection methodology introduced in January 1994. Revised population estimates based on the 1990 census, adjusted for the estimated undercount, also were incorporated. In 1996, previously published data for the 1990-93 period were revised to reflect the 1990 census-based population controls, adjusted for the undercount. In 1997, revised population controls were introduced into the household survey. Therefore, the data are not strictly conparable with prior years. In 1998, new composite estimation procedures and minor revisions in population controls were introduced into the household survey. Therefore, the data are not strictly comparable with data for 1997 and earlier years. See the Notes section on Employment and Unemployment Data of this Review.

For France, the 1992 break reflects the substitution of standardized European Union Statistical Office (EUROSTAT) unemployment statistics for the unemployment data estimated according to the International Labor Office (mo) definition and published in the Organization for Economic Cooperation and Development (OECD) annual yearbook and quarterly update. This change was made because the EUROSTAT data are more up-to-date than the OECD figures. Also, since 1992, the EUROSTAT definitions are closer to the U.S. definitions than they were in prior years. The impact of this revision was to lower the unemployment rate by 0.1 percentage point in 1992 and 1993, by 0.4 percentage point in 1994, and 0.5 percentage point in 1995.

For Italy, the 1991 break reflects a revision in the method of weighting sample data. The impact was to increase the unemployment rate by approximately 0.3 percentage point, from 6.6 to 6.9 percent in 1991.

In October 1992, the survey methodology was revised and the definition of unemployment was changed to include only those who were actively looking for a job within the 30 days preceding the survey and who were available for work. In addition, the lower age limit for the labor force was raised from 14 to 15 years. (Prior to these changes, BLS adjusted Italy's published unemployment rate downward by excluding from the unemployed those persons who had not actively sought work in the past 30 days.) The break in the series also reflects the incorporation of the 1991 population census results. The impact of these changes was to raise Italy's adjusted unemployment rate by approximately 1.2 percentage points, from 8.3 to 9.5 percent in fourth-quarter 1992. These changes did not affect employment significantly, except in 1993. Estimates by the Italian Statistical Office indicate that employment declined by about 3 percent in 1993, rather than the nearly 4 percent indicated by the data shown in table 44. This difference is attributable mainly to the incorporation of the 1991 population benchmarks in the 1993 data. Data for earlier years have not been adjusted to incorporate the 1991 census results.

For the Netherlands, a new survey questionnaire was introduced in 1992 that allowed for a closer application of iLo guidelines. EUROSTAT has revised the Dutch series back to 1988 based on the 1992 changes. The 1988 revised unemployment rate is 7.6 percent; the previous estimate for the same year was 9.3 percent.

There have been two breaks in series in the Swedish labor force survey, in 1987 and 1993. Adjustments have been made for the 1993 break back to 1987. In 1987, a new questionnaire was introduced. Questions regarding current availability were added and the period of active workseeking was reduced from 60 days to 4 weeks. These changes lowered Sweden's 1987 unemployment rate by 0.4 percentage point, from 2.3 to 1.9 percent. In 1993, the measurement period for the labor force survey was changed to represent all 52 weeks of the year rather than one week each month and a new adjustment for population totals was introduced. The impact was to raise the unemployment rate by approximately 0.5 percentage point, from 7.6 to 8.1 percent. Statistics Sweden revised its labor force survey data for 1987-92 to take into account the break in 1993. The adjustment raised the Swedish unemployment rate by 0.2 percentage point in 1987 and gradually rose to 0.5 percentage point in 1992.

Beginning with 1987, BLS has adjusted the Swedish data to classify students who also sought work as unemployed. The impact of this change was to increase the adjusted unemployment rate by 0.1 percentage point in 1987 and by 1.8 percentage points in 1994, when unemployment was higher. In 1998, the adjusted unemployment rate had risen from 6.5 to 8.4 percent due to the adjustment to include students.

The net effect of the 1987 and 1993 changes and the BLS adjustment for students seeking work lowered Sweden's 1987 unemployment rate from 2.3 to 2.2 percent.

FOR ADDITIONAL INFORMATION on this series, contact the Division of Foreign Labor Statistics: (202) 691-5654.

Manufacturing productivity and labor costs

Description of the series

Table 45 presents comparative indexes of manufacturing labor productivity (output per hour), output, total hours, compensation per hour, and unit labor costs for the United States, Canada, Japan, and nine European countries. These measures are trend comparisons-that is, series that measure changes over time-rather than level comparisons. There are greater

technical problems in comparing the levels of manufacturing output among countries.

BLS constructs the comparative indexes from three basic aggregate measures---output, total labor hours, and total compensation. The hours and compensation measures refer to all employed persons (wage and salary earners plus self-employed persons and unpaid family workers) in the United States, Canada, Japan, France, Germany, Norway, and Sweden, and to all employees (wage and salary earners) in the other countries.

Definitions

Output, in general, refers to **value** added in manufacturing from the national accounts of each country. However, the output series for Japan prior to 1970 is an index of industrial production, and the national accounts measures for the United Kingdom are essentially identical to their indexes of industrial production.

The 1977-97 output data for the United States are the gross product originating (**value** added) measures prepared by the Bureau of Economic **Analysis** of the U.S. Department of Commerce. Comparable manufacturing output data currently are not available prior to 1977.

U.S. gross product originating is a chaintype annual-weighted series. (For more information on the U.S. measure, see Robert E. Yuskavage, "Improved Estimates of Gross Product by Industry, 1959-94," Survey of Current Business, August 1996, pp. 13355.) The Japanese **value** added series is based upon one set of fixed price weights for the years 1970 through 1997. Output series for the other foreign economies also employ fixed price weights, but the weights are updated periodically (for example, every 5 or 10 years).

To preserve the comparability of the U.S. measures with those for other economies, BLS uses gross product originating in manufacturing for the United States for these comparative measures. The gross product originating series differs from the manufacturing output series that BLS publishes in its news releases on quarterly measures of U.S. productivity and costs (and that underlies the measures that appear in tables 39 and 41 in this section). The quarterly measures are on a "sectoral output" basis, rather than a valueadded basis. Sectoral output is gross output less intrasector transactions.

Total labor hours refers to hours worked in all countries. The measures are developed from statistics of manufacturing employment and average hours. The series used for France (from 1970 forward), Norway, and Sweden are official series published with the national accounts. Where official total hours series are not available, the measures are developed by BLS using employment figures published with the national accounts, or other comprehensive employment series, and estimates of annual hours worked. For Germany, BLS uses estimates of average hours worked developed by a research institute connected to the Ministry of Labor for use with the national accounts employment figures. For the other countries, BLS constructs its own estimates of average hours.

Denmark has not published estimates of average hours for 1994-97; therefore, the BLs measure of labor input for Denmark ends in 1993.

Total compensation (labor cost) includes all payments in cash or in-kind made directly to employees plus employer expenditures for legally required insurance programs and contractual and private benefit plans. The measures are from the national accounts of each country, except those for Belgium, which are developed by BLS using statistics on employment, average hours,

and hourly compensation. For Canada, France, and Sweden, compensation is increased to account for other significant taxes on payroll or employment For the United Kingdom, compensation is reduced between 1967 and 1991 to account for employment-related subsidies. Self-employed workers are included in the all-employed-persons measures by assuming that their hourly compensation is equal to the average for wage and salary employees.

Notes on the data

In general, the measures relate to total manufacturing as defined by the International Standard Industrial Classification. However, the measures for France (for all years) and Italy (beginning 1970) refer to mining and manufacturing less energy-related products, and the measures for Denmark include mining and exclude manufacturing handicrafts from 1960 to 1966.

The measures for recent years may be based on current indicators of manufacturing output (such as industrial production indexes), employment, average hours, and hourly compensation until national accounts and other statistics used for the long-term measures become available.

FOR ADDITIONAL INFORMATION on this series, contact the Division of Foreign Labor Statistics: (202) 691-5654.

Occupational Injury and Illness Data

(Tables 46-47)

Survey of Occupational Injuries and Illnesses

Description of the series

The Survey of Occupational Injuries and Illnesses collects data from employers about their workers' job-related nonfatal injuries and illnesses. The information that employers provide is based on records that they maintain under the Occupational Safety and Health Act of 1970. Self-employed individuals, farms with fewer than 11 employees, employers regulated by other Federal safety and health laws, and Federal, State, and local government agencies are excluded from the survey.

The survey is a Federal-State cooperative program with an independent sample selected for each participating State. A stratified **random** sample with a Neyman allocation is selected to represent all private industries in the State. The survey is stratified by Standard Industrial Classification and size of employment.

Definitions

Under the Occupational Safety and Health Act, employers maintain records of nonfatal work-related injuries and illnesses that involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment other than first aid.

Occupational injury is any injury such as a cut, fracture, sprain, or amputation that results from a work-related event or a single, instantaneous exposure in the work environment.

Occupational illness is an abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to factors associated with employment. It includes acute and chronic illnesses or disease which may be caused by inhalation, absorption, ingestion, or direct contact.

Lost workday injuries and illnesses are cases that involve days away from work, or days of restricted work activity, or both.

Lost workdays include the number of workdays (consecutive or not) on which the employee was either away from work or at work in some restricted capacity, or both, because of an occupational injury or illness. BLS measures of the number and incidence rate of lost workdays were discontinued beginning with the 1993 survey. The number of days away from work or days of restricted work activity does not include the day of injury or onset of illness or any days on which the employee would not have worked, such as a Federal holiday, even though able to work.

Incidence rates are computed as the number of injuries and/or illnesses or lost work days per 100 full-time workers.

Notes on the data

The definitions of occupational injuries and illnesses are from Recordkeeping Guidelines for Occupational Injuries and Illnesses (U.S. Department of Labor, Bureau of Labor Statistics, September 1986).

Estimates are made for industries and employment size classes for total recordable cases, lost workday cases, days away from work cases, and nonfatal cases without lost workdays. These data also are shown separately for injuries. Illness data are available for seven categories: occupational skin diseases or disorders, dust diseases of the lungs, respiratory conditions due to toxic agents, poisoning (systemic effects of toxic agents), disorders due to physical agents (other than toxic materials), disorders associated with repeated trauma, and all other occupational illnesses.

The survey continues to measure the number of new work-related illness cases which are recognized, diagnosed, and reported during the year. Some conditions, for example, long-term latent illnesses caused by exposure to carcinogens, often are difficult to relate to the workplace and are not adequately recognized and reported. These long-term latent illnesses are believed to be understated in the survey's illness measure. In contrast, the overwhelming majority of the reported new illnesses are those which are easier to directly relate to work-place activity (for example, contact dermatitis and carpal tunnel syndrome).

Most of the estimates are in the form of incidence rates, defined as the number of injuries and illnesses per 100 equivalent fulltime workers. For this purpose, 200,000 employee hours represent 100 employee years (2,000 hours per employee). Full detail on the available measures is presented in the annual bulletin, Occupational Injuries and Illnesses: Counts, Rates, and Characteristics.

Comparable data for more than 40 States and tern-tories are available from me BLS Office of Safety, Health and Working Conditions. Many of these States publish data on State and local government employees in addition to private industry data.

Mining and railroad data are furnished to aLs by the Mine Safety and Health Administration and the Federal Railroad Administration. Data from these organizations are included in both the national and State data published annually.

With the 1992 survey, BLs began publishing details on serious, nonfatal incidents resulting in days away from work. Included are some major characteristics of the injured and ill workers, such as occupation, age, gender, race, and length of service, as well as the circumstancinjuries and illnesses (nature of the disabling condition, part of body affected, event and exposure, and the source directly producing the condition). In general, these data are available nationwide for detailed industries and for

individual States at more aggregated industry levels.
FOR ADDITIONAL INFORMATION on occupational injuries and illnesses, contact the Office of Occupational Safety, Health and Working Conditions at (202) 691-6180, or access the Internet at:

http://www.bls.gov/oshhome.htm

Census of Fatal Occupational Injuries

The Census of Fatal Occupational Injuries compiles a complete roster of fatal job-related injuries, including detailed data about the fatally injured workers and the fatal events. The program collects and cross checks fatality information from multiple sources, including death certificates, State and Federal workers' compensation reports, Occupational Safety and Health Administration and Mine Safety and Health Administration records, medical examiner and autopsy reports, media accounts, State motor vehicle fatality records, and follow-up questionnaires to employers.

In addition to private wage and salary workers, the self-employed, family members, and Federal, State, and local government workers are covered by the program. To be included in the fatality census, the decedent must have been employed (that is working for pay, compensation, or profit) at the time of the event, engaged in a legal work activity, or present at the site of the incident as a requirement of his or her job.
Definition

A fatal work injury is any intentional or unintentional wound or damage to the body resuiting in death from acute exposure to energy, such as heat or electricity, or kinetic energy from a crash, or from the absence of such essentials as heat or oxygen caused by a specific event or incident or series of events within a single workday or shift. Fatalities that occur during a person's commute to or from work are excluded from the census, as well as work-related illnesses, which can be difficult to identify due to long latency periods.

Notes on the data

Twenty-eight data elements are collected, coded, and tabulated in the fatality program, including information about the fatally injured worker, the fatal incident, and the machinery or equipment involved. Summary worker demographic data and event characteristics are included in a national news release that is available about 8 months after the end of the reference year. The Census of Fatal Occupational Injuries was initiated in 1992 as a joint Federal-State effort. Most States issue summary information at the time of the national news release.

FOR ADDITIONAL INFORMATION on the Census of Fatal Occupational Injuries contact the BLS Office of Safety, Health, and Working Conditions at (202) 691-6175, or the Internet at:

http:/www.bls.gov/oshhome.htm

Bureau of Labor Statistics Internet

The Bureau of Labor Statistics World Wide Web site on the Internet contains a range of data on consumer and producer prices, employment and unemployment, occupational compensation, employee benefits, workplace injuries and illnesses, and productivity. The homepage can be accessed using any Web browser:

http:/stats.bls.gov

Also, some data can be accessed through anonymous FrP or Gopher at

stats.bls.gov

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Geographic Names: United States; US

Descriptors: Statistical analysis; Economic conditions
Classification Codes: 1110 (CN=Economic conditions & forecasts); 9140 (CN=Statistical data); 9190 (CN=United States)
Print Media ID: 28847

30/9/5 (Item 5 from file: 15)
02104078 65553767
Judgements about computer ethics: Do individual, co-worker, and company judgements differ? Do company codes make a difference?

Pierce, Margaret Anne; Henry, John W
Journal of Business Ethics v28n4 pp: 307-322
Dec 2000
CODEN: JBUEDJ
ISSN: 0167-4544 Journal Code: JBE
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 16 Pages
Special Feature: Formula Table
Word Count: 7156

Abstract:

When faced with an ambiguous ethical situation related to computer technology (CT), the individual's course of action is influenced by personal experiences and opinions, consideration of what co-workers would do in the same situation, and an expectation of what the organization might sanction. In this article, the judgement of over 300 Association of Information Technology Professionals members concerning the actions taken in a series of CT ethical scenarios are examined. Respondents expressed their personal judgement, as well as their perception of their co-workers' judgement, and their understanding of the organization's judgement of the actions described in the scenarios. The findings show that there are differences in respondents' judgements for self, co-workers, and organization. Definitive patterns were also found between groups with and without organizational codes related to CT.

Text:

ABSTRACT When faced with an ambiguous ethical situation related to computer technology (CT), the individual's course of action is influenced by personal experiences and opinions, consideration of what co-workers would do in the same situation, and an expectation of what the organization might

sanction. In this article, the judgement of over three-hundred Association of Information Technology Professionals (AITP) members concerning the actions taken in a series of CT ethical scenarios are examined. Respondents expressed their personal judgement, as well as their perception of their co-workers' judge

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KEY WORDS: computer abuse, company codes, computer ethics
Introduction

While spectacular computer technology (CT) abuse cases make the evening news they represent only the "tip of the iceberg". Many unethical CT related actions are resolved within the organization, perhaps with little notice even by fellow employees (Straub and Nance, 1990). These unethical acts and the related discipline of them can consume enormous amounts of organizational human and **financial** resources (e.g., lawsuits, effects on employee morale, compromise of corporate information) and may lead to unfavorable public images of the organization (Martin and Martin, 1990; Pelfrey and Peacock, 1991; Robideaux et al., 1993; Straub and Nance, 1990). With the complexity and uncertainty that organizations face in their external environments, they certainly do not need additional problems related to the unethical use of CT exposed to the public. Reports show that the public is extremely cautious about how organizations use CT and tend to attach a "big brother" attribute to its use (Rifkin, 1991; Paradice, 1990; Parker, 1981; Skinner et al., 1988). Thus, negative perceptions can cause loss in sales, drops in stock prices, etc.

Rather than malicious, some of these unethical acts are the result of an individual's uncertainty or misunderstanding of appropriate behavior. Paradice (1990) expresses this as follows:

"Acceptable behavior" may be a particularly ambiguous concept in the information systems field, since the field is still relatively young and is evolving at a tremendously rapid pace. (p. 143)

In other words, in many instances, there are either no "rules" or an incomplete understanding of guidelines to direct behavior. More recently, Loch and Conger (1996) have expressed continued concern as CT permeates the work place and suggest that a lack of guidance has led to situations where ". . . ethical questions with respect to computer usage are multiplying" (p. 75).

With all the controversy and fear of repercussions, the question becomes "How does one select the 'right' action to take when an ambiguous situation is encountered?". The individual looks for guidance from numerous sources. Obviously, previous personal experiences influence actions in ambiguous ethical situations. Moreover, one considers what co-workers would do in the same situation and what the organization would sanction. In the organizational setting, social norms or social pressures to perform or avoid some behavior derive from personal norms, co-worker norms, and organizational norms (Ajzen and Fishbein, 1980; Cassell et al., 1997; Sims and Keon, 1999; Victor and Cullen, 1988). In some organizations, appropriate behaviors are communicated more formally by company codes that address, at least to some extent, CT.

Ultimately, judgements related to the use of CT are made by individuals. However, their judgements are influenced by their co-workers and the

organization. The individual is faced with the problem of resolving these external expectations with his/her on personal norms. This study examines the extent to which individuals perceive that their judgement differs from co-worker norms and organizational norms. Since organizational codes purport to shape norms and guide behavior, the study also examines the differences in judgements for those who do/do not have organizational codes of ethics.

The research objectives are accomplished by examining the approval/disapproval ratings of over three-hundred Association of Information Technology Professionals (AITP) members concerning the actions described in a series of CT ethical scenarios. Respondents expressed their personal judgement of the action taken in each scenario as well as how they believed their coworkers and the organization would judge each action. The **analysis** focuses on the differences in these responses. The fundamental objective of CT ethics research is to facilitate informed, responsible ethical judgements and therefore ethical behavior. If significant differences across judgements of the actions in the scenarios exist, perhaps insight will be gained into the ethical decision making process and the inherent difficulties associated with reconciling personal norms, co-worker norms, and organizational norms.

Computer ethics research
Conflict: Personal norms, co-worker norms, and organizational norms

Personal norms, co-worker norms, and organizational norms are taken into account as employees make ethical decisions (Sims and Keon, 1999). A conceptual model showing the relationship among these factors in the general organizational setting as well as an excellent review of the literature related to each is given by Cassell et al. (1997). In the Cassell et al. model (1997, p. 1089), formal controls and social controls (peer influences) are shown to influence the behavior of the individual. A similar model for Computer Technology (CT) ethical decisionmaking was developed and tested for the CT setting (Henry and Pierce, 1994; Pierce and Henry, 1996). It is especially difficult for an individual to decide what action to take if co-workers expect one action, organizational management another, and one's personal judgement indicates yet another course of action. This ethical ambivalence constitutes what Waters and Bird (1987) call "moral stress" which is described as ". . . an incon-gruence between organizational and individual perspectives on ethical matters." (Wyld and Jones, 1997, p. 470). Constructs such as "moral stress" and co-worker norms have been proposed and tested in the general business setting but not applied specifically to CT situations (Victor and Cullen, 1988, Waters and Bird, 1987).

The effect of the incongruence is felt at two levels: the individual level and organizational level. At the individual level, a feeling of congruence of these perspectives is of primary importance. An incongruence or "mismatch" is manifest in behaviors such as turnover, absenteeism and decreased organizational commitment (Victor and Cullen, 1988). Within the organization, organizations influence their employees as well as ways employees influence each other; these forces are characterized as "organizational ethics" (Horvath, 1999). Organizational ethics includes normative and contextual guidelines for behavior. Thus, there is another source of disparity in expectations conveyed between organizational expectations and peer expectations. At the organizational level, the primary concern is individual or group behaviors that result from the incongruence. In situations which involve CT, this "moral stress" or disparity in expectations is likely to be complicated by the absence of any guidance in a number of areas (Paradice, 1990). Even computer professionals disagree on ethical judgements related to CT situations (Weiss, 1982; Athey, 1993). Thus, this literature suggests a study of the extent to which

personal norms, co-worker norms, and organizational norms are incongruent. The following research question is proposed:

In CT ethical situations, are there differences among personal norms, the individual's judgements of co-worker norms, and the individual's judgement of the organizational norms?

The impact of formal organizational codes of computer ethics

In the business environment, one avenue used to communicate ethics is a formal code or statement of company policy (Nijhof and Rietdijk, 1999; Pelfrey and Peacock, 1991; Stevens, 1999; Stevens, 1994; Straub and Nance, 1990; Wyld and Jones, 1997). **Historical** events have also influenced the increased use of organizational codes of ethics. After the Watergate scandal in 1975, government regulation in the form of the Foreign Corrupt Practices Act of 1977 was passed in reaction to implications of illegal and questionable practices of a number of corporations (Stevens, 1994). Expectations of corporate behavior continued to change during the 1980's and there was an increase in litigation surrounding organizational practices (Cleek and Leonard, 1998). For example, in the 1991 Federal Sentencing Guidelines a company is held responsible for "acts of its agents and employees" (Maurer, 1993), and a part of the sentence imposes on the organization a responsibility to show how the behavior will be avoided in the future. Thus, the Code of Ethics has become an important element in the management of an organization. Organizational codes of ethics are shown in the Cassell et al. model (1997, p. 1089) mentioned above as exerting influence directly on the formal controls, the individual, and the social controls. They put the impact of the Code of Ethics in context as follows:

Given the probability of the existence of a cultural plurality in any organization, how members respond to the ethical injunctions articulated by an organization-wide Code of Ethics may be mediated by and dependent upon, the nature of established customs, values and mores of the group of significant others with whom any individual identifies. (Cassell et al., 1997, p. 1085)

While most organizational codes of ethics are general statements of policy and expectations, some codes address specific topics (Ethics Resource Center, 1990; Kaptein and Wempe, 1999; Molander, 1987). Although some argue that generic codes are adequate to convey responsibilities Johnson and Mulvey, 1995), some attention has been given to developing organizational codes of ethics which specifically address CT. Development of specific CT codes came as a result of employees' inability to interpret the general code sufficiently as well as the nature of the technology which depersonalizes relationships and provides anonymity (Conger, Loch, and Helft, 1995; Harrington, 1996; Kallman, 1992). Kallman (1992) says that to be effective these codes must be written such that they provide guidance to all users of CT not just the "computer professionals" in the organization. Several authors indicate that one key to managing the risk of unethical CT use is creating, reinforcing, and maintaining an ethical environment supported by top management (Kallman, 1992; Paradice, 1990).

Research related to codes of ethics has taken several forms. A good deal of work has related to content **analysis** of codes and transmission of information about codes (Stevens, 1994; Stevens, 1999). The research related to the effectiveness of codes has been mixed. Because it is difficult to gather data in the organizational setting, particularly across organizations, frequently student samples are used, and the application of results to the organizational context is questionable. Some findings suggest that a code of ethics does make a difference in the behavior of members of an organization. For example, Robideaux, Miles, and White (1993), in their examination of a firm's capital budget and planning procedures, found that the presence of a code of ethics that specifically

addressed capital budgeting/strategic planning decisions raised the awareness of social responsibility in the long run planning process. In addition, Brenner and Molander (1977) found that business executives looked not only to actions of their superiors but also to formal organizational policy, peer behavior, and industry norms for guidance when faced with pressure to commit unethical acts. Molander (1987) states that the tendency of executives to rationalize their own misconduct by pointing to unethical acts by others and a lack of formal company policy suggests that an ethical code could provide the kind of guidance executives seem to want and need" (p. 623).

As suggested above, there is a debate related to the effectiveness of codes of ethics in influencing behavior related to CT. Investigating the major role of codes of ethics to clarify responsibility and to deter unethical responsibility, Harrington (1996) found that individual psychological traits mediate the impact of codes; therefore, some types of codes are effective for some people.
The focus in the current study is the perspectives of the individual, the individual's judgment about the beliefs of co-workers, and the individual's beliefs about the company. The "code" literature suggests exploring differences between employees in organizations with and without codes and thus the following research question:

Does the presence of an organizational CT ethics code have a positive effect on the awareness of ethical behavior?

Research strategy

Much previous research with CT ethics topics used either undergraduate and graduate students (e.g., Paradice and Dejoie, 1991; Sims and Keon, 1999) or Management Information Systems (MIS) faculty and identified experts (e. g., Parker, 1979; 1981) and does not reflect the larger community of computer professionals. Subjects in the current study were CT professionals. A survey approach was taken in order to obtain information from a number of different CT professionals across organizations in the US., thus, obtaining more generalizable results. Using the work of Paradice (1990), a questionnaire was designed to test the research questions.

Consistent with other ethics research (Fritzsche and Becker, 1984; Grover, 1993; Straub and Nance, 1990) data was obtained using a mail survey. A questionnaire containing scenarios involving computer-related behavior was used to elicit ethical judgements from respondents. This approach has been used in other studies and was deemed appropriate for the current study (Paradice, 1990; Parker, 1981). As Trevino (1992) states in her discussion of methods for studying ethical/unethical behavior in organizations, "Scenarios may be extremely useful vehicles for understanding subjects' judgements in hypothetical ethical decision situations" (Trevino, 1992, p. 128). Every effort was made to reduce the chance that respondents might give socially desirable responses. The questionnaire was not numbered or coded; the cover letter accompanying the instrument contained assurances of anonymity as well as indicating that data would be reported only in aggregate form.

The questionnaire

Each scenario presented an ethical situation related to CT and the action taken by an employee or department. The three general areas, obligation, opportunity, and intent, were selected as scenario topics because they have been identified in previous studies as significant variables which determine individual behavior (Johnson, 1985; Parker, 1981; Paradice, 1990). Moreover, the scenario categories represent a broad range of activities common to many organizational settings. The nine scenarios

suggested by Paradice (1990) and shown in Table I were used in the study; three scenarios relate to obligation, three to opportunity, and three to intent. Paradice (1990) defined these terms as follows: an obligation is a responsibility to others; an opportunity is a set of favorable conditions with at least limited barriers and perhaps even rewards, and an intent is a reason or motive for action. Intent, in the context of use of CT resources, relates to personal profit, personal nonprofit, or company profit.

The following instructions were provided to the respondents:

Please read the following scenarios and the action taken in each. Assume that you, your co-workers, and the company management have knowledge of the incident and action. For each action, please indicate your opinion, the likely opinion of your co-workers, and the likely company position regarding each action.

The following format was used for all scenarios and responses:

The company pays for computer time on a large computer.

Action: An employee plays games on the system.

Respondents judged the action described in the scenario on a five-point Likert-type scale (1932) from strongly approve to strongly disapprove. Besides their own response to the action, the respondents judged what they thought their coworkers' and company's approval/disapproval ratings would be. To avoid biasing responses, the categorizations of the scenarios were not included on the questionnaire.

In addition, demographic information including age, gender, education, position, and professional certification was requested. The respondents were also asked if their company had a formal code of ethics with provisions related to CT.

Source of data

While it might be interesting to look at all computer users, computer professionals across industries and company positions were considered appropriate for this study since these professionals are generally more often exposed to ethical questions and decisions (Straub and Nance, 1990; Paradice, 1990). Like Straub and Nance (1990), we found a stratified **random** sample of Association of Information Technology (AITP) members to be appropriate since we sought to generalize across CT professionals. The mailing list was stratified by industry insuring representative coverage from various types of computing environments. Thus, the sample used represents the population to which we wish to generalize-across organizations, industries, and positions.

Data **analysis** techniques

The **analysis** of data was done using the Statistical Package for the Social Sciences (1990). A descriptive **analysis** provided means, standard deviations, and modes for each part of each question and provided an overview of the approval/disapproval of the actions described in the scenarios. The first research question examined differences in "your opinion" (personal judgement), "opinion of coworker" (judgement of co-worker norm), and 44 company position" judgement of organizational norms) responses for each scenario. Personal, coworker, and organizational responses for each scenario were tabulated, and a multiple **analysis** of variance (MANOVA) was conducted for each scenario to determine if the mean responses for personal, co-worker, and organization differed.

For a given scenario, if all parts were complete, the response was used in the **analysis**; however, if any part of the response was missing, all ratings for that scenario were omitted in the **analysis**. If this overall test showed significant differences in the means, a post-hoc Hotelling test was performed to indicate which pairs of means differed (Zar, 1984).

The second research question examined differences between respondents working for organizations with and without formal CT codes of ethics. Respondents were grouped by whether or not their organization had a formal company code which related to CT ethics, and the means for the code and no code groups were computed for each response (personal, co-worker, and organization) in each of the nine scenario questions. One-tailed difference in means t-tests were conducted to determine if those who worked for organizations with CT codes indicated higher disapproval ratings than those whose organization had no CT related codes.

All p-values for both research questions are reported. Those values with level of significance at the 0.001, 0.01, and 0.05 level are discussed in the findings.

The sample

To obtain the data, a cover letter, the questionnaire, and a metered return envelope were mailed to a **random** sample of 2551 AITP members. A return rate of approximately 14% yielded 356 responses. On some questionnaires not all question parts were completed; therefore, some of the analyses used fewer responses (see Table II).

Sample demographics

The percentage of AITP members (as well as in the stratified **random** sample) parallels the percentage of the returned questionnaires for industries categorized as **financial**/real estate, wholesale/retail, utilities, DP services/consultant, manufacturing, and other. The percentages of returns were fewer than expected in the education/medical/legal area (returns 16.1%; AITP 27.7%) and more than expected in the government category (returns 9.3%; AITP 5.8%). Nevertheless, the numbers appear to indicate that the returns obtained were representative of the population of AITP members.

Other demographic characteristics of the sample appear in Table III. This demographic profile of the respondents provides evidence that the sample represents the population of computer professionals.

About one-half (48%) of the respondents said that their organization had a formal code containing CT topics. It appears from examination of the quartiles of the company size for the code and no code groups found in Table III that respondents in the no code group work for smaller companies work overall work for smaller companies. Twenty-four formal codes of ethics were enclosed with returned questionnaires. These codes vary from specific guidelines for behavior to general statements about organizational policy.

In survey research, the potential for response bias always exists. This bias exists when the responses do not represent the population sampled; that is, those who took the time to respond have different characteristics that the larger population. The characteristics of the early/late participants were studied in order to examine any response bias that might be present in the sample (Armstrong and Overton, 1977). **Analysis** using difference in means t-tests were performed for early/late responses on the following demographics: age, position, certification, years in

profession, years in present job, and size of the organization. No significant differences were found ($p < 0.05$) indicating no systemic bias in the responses. From characteristics of the respondents and their distribution, it seems that the data represent a wide range of computing professionals which parallels the population of AITP members.

TABLE I

TABLE II

Descriptive statistics

The descriptive statistics provide an overview of the patterns of responses. Table II contains summary statistics for the nine scenario questions. For each question, the mode, mean, standard deviation, and number of usable responses are given for personal, co-workers, and organization. Recall that the five-item bipolar scale (1-strongly approve/5-strongly disapprove) was used for ratings.

Findings related to research questions

Differences among personal, co-worder, and organization

In CT ethical situations, are there differences among personal judgement, the individual's judgement of co-worker norms, and the individual's judgement of the organizational norms? For each scenario, personal, co-worker, and organization approval/disapproval judgements were examined to explore the extent to which the judgements were consistent. Multiple **analysis** of variance (MANOVA) procedures yielded Fstatistics significantly different from zero at the 0.001 level of significance for each of the nine scenarios. The results are summarized in Table IV These results indicate that judgements differ among personal, co-worker, and organization in each of the nine scenarios.

Since differences were found, follow-up tests were performed; the results of post-hoc Hotelling 95% confidence **interval** tests are also shown in Table IV Specifically, there were differences between the means for personal and co-worker in five scenarios (scenarios 1, 4, 5, 8, and 9); coworker and organization means differed significantly in seven scenarios (scenarios 1, 2, 3, 4, 5, 7, 8). In contrast, personal and organizational approval/disapproval differed in only three scenarios (scenarios 2, 3, 7). As shown in Table IV, there was no scenario in which differences were significant for the three pairs of means; although, for seven of the nine scenarios, there were two pairs of differences (scenarios 1, 2, 3, 4, 5, 7, 8).

Patterns of results for the three types of scenarios were observed. In obligation scenarios, two of the three showed no difference in personal and co-worker means, but all of the co-worker and company means differed. In contrast, there are no differences in any of the personal and company means of the opportunity scenarios. The opportunity for disruptive behavior scenario showed no differences for any specific pairs of means although the overall test revealed differences. Also the intent scenarios showed no difference in two of the three personal and company means.

TABLE III

Differences between organization code/no code groups

Does the presence of an organizational CT ethics code have a positive effect on the awareness of ethical behavior? To test this research question, first the responses were placed into two groups (referenced as code/no code groups). For each scenario, group means for personal,

co-worker, and organizational approval/disapproval ratings were compared to detect if the disapproval was greater in the code group. A one-tailed difference in means t-test was performed for each part (personal, co-worker, and organization) of the nine scenarios. The patterns of differences are shown in Table V in which p-values are given and statistically significant differences are shown. Means and standard deviations for the code/no code groups are also in Table V.
The **analysis** showed that there were differences in judgements between the code and no code groups in six of the nine scenarios. For personal judgements, the **analysis** revealed that the only scenario in which respondents from organizations with CT related codes indicated more disapproval of the action described was intent-use of resources for company profit (scenario 9). Respondents' judgements of their co-workers' ratings in the code group showed more disapproval than the no code group of the action in opportunity to obtain software (scenario 4) and intent-use of resources for company profit (scenario 9). In contrast, judgements of organizational disapproval ratings were significantly greater for the code group in six scenarios (scenarios 1, 3, 4, 5, 7, and 9); the only exceptions were obligation of responsibility (scenario 2), opportunity for disruptive behavior (scenario 6), and intent-use of resources personal profit (scenario 8).

TABLE IV

Patterns of multiple differences in judgements were found in only two scenarios. The respondents in the code group, when making judgements for co-worker and organization response to the action, showed more disapproval than the no code group in opportunity to obtain software (scenario 4). The only category in which differences were not found in scenario 4 was personal, but the mean for all personal responses to the obtain software scenario is very high (see Table VI). Multiple differences were also found in the responses to intent-use of resources company profit (scenario 9); the results show more disapproval by the code group in all categories (personal, co-worker, organization). No patterns were observed by type (obligation, opportunity, intent) of scenario.

Discussion of findings

Scenarios presented to respondents involved a variety of CT ethical situations. Respondents were asked to rate their own (personal) approval/disapproval of the action described in each scenario; in addition, they were instructed to make a judgement about the ratings that would be given by their co-workers and the organization. Judgements of approval/disapproval were used to operationalize perceptions of personal and social (co-worker and organization) norms. Interesting differences were found among approval/disapproval judgements for personal, co-workers, and organization. In addition, definitive patterns were found between respondent groups with and without organizational codes of CT ethics. These findings will be discussed below.

Differences among personal, co-worker, and organization

In CT ethical situations, are there differences among personal judgements, the individual's judgements of co-worker norms, and the individual's judgement of the organizational norms? In addition to overall significant differences among personal, co-worker, and organization ratings for all scenarios, personal approval ratings of scenario action differed from either co-worker or organization judgements in eight of the nine scenarios. The findings suggest that personal social norms may impose a different set of "rules of behavior" than the co-worker norms or the organization norm representing the "party line". Furthermore, the individual may also perceive differences between co-worker norms and organizational norms. The

findings suggest that personal social norms, co-worker norms, and organizational norms are not congruent indicating a possible absence of "shared values" regarding appropriate use of CT (Alexander, 1987) and the existence of "moral stress", at least to some degree. Thus, it is not surprising that individuals have trouble making decisions about what is "acceptable behavior" in CT ethical situations (e.g., personal judgements differed from judgements of co-worker norms, personal judgements differed from judgements of organizational norms and co-worker norms differed from organizational norms in various scenarios). These finding are particularly interesting since the individual is part of the organizational culture and presumably takes part in setting the co-worker norms and organizational norms (Froelich and Kottke, 1991). The "everybody else does it" syndrome (Pelfrey and Peacock, 1991) is reflected here in co-worker norms, but the responding individuals do not seem to believe it is appropriate ethical behavior in all situations. Specifically, in the current study individual and co-worker norms seemed to differ in scenarios 1, 4, 5, 8, and 9 (see Table IV). Perhaps more striking is that the co-worker and company differ in seven of the nine scenarios. In addition, the results suggest less disagreement about opportunity and intent by self and company, and less disagreement between self and co-worker regarding obligation. If we consider the personal response the "high road" as far as the individual is concerned, the co-worker is seen as agreeing with this view when is comes to obligations described. The company stance generally coincides with the personal view in situations involving opportunity and intent.

Differences between organization code/no code groups

Does the presence of an organizational CT ethics code have a positive effect on the awareness of ethical behavior? The results suggest that the organization is perceived as more disapproving of questionable actions by those computer professionals who work for organizations which have CT ethics codes. Possibly, respondents who work for organizations with codes credit co-workers and the organization with a higher moral standard. Additionally, respondents whose organizations have CT ethics codes showed more personal disapproval of software copying and questionable use of information for company profit. No patterns are observed in differences by scenario type (obligation, opportunity, intent). The results suggest that the organizational CT code shapes organizational norms in a positive but limited fashion. Perhaps organizational codes lack specificity and are not fully integrated into the immediate work context; therefore, the codes may not have maximum impact on individual and co-worker norms. This research does not seem to support the notion that the "organizational climate" links the organization to the individual as suggested by Wyld and Jones (1997).

TABLE V

TABLE VI

The current research confirms that organizational CT codes have an effect; the respondents who worked for organizations with CT codes judged that the organization would have higher disapproval ratings in six of the nine scenarios than the respondents who worked for organizations with no codes. Clearly, the effect is circular. Even though the organization may set the ethical climate with codes, the process is interactive since the individual must accept the code and use it to guide behavior.

Conclusions

Implications

There were differences among the individual's judgement of actions in CT ethical scenarios, the individual's judgement of their co-workers' rating

of the actions, and individual's judgement of the organization's rating of the same actions, thus indicating a lack of congruence from the individual's pespective in expectations arising from personal norms, co-worker norms, and organizational norms. The problem for researchers and professionals is to discover ways of clarifying expectations about CT ethical behavior so that the individual's personal norms and co-worker norms are congruent with organizational norms (assuming that they are "ethical"), thus avoiding "moral stress" for the individual and its resulting negative consequences for both the individual and the organization. The message for the company might be to take advantage of the congruence in thinking related to opportunity and intent and explore reasons for the differences where they exist. For example, if the individual perceives differences in co-worker and company approaches to ethical issues, clarification and discussion of policy is warranted.

Most ethical decisions are influenced primarily by the immediate work context (Anderson, Johnson, Gotterbarn and Perrolle, 1993). A source of explicit guidance for the individual is an organizational code, either a general one or one related to CT. Differences in approval/ disapproval ratings were seen between computer professionals who work for organizations with formal codes of ethics and those who work for organizations without codes. However, most differences were in individuals' judgments about organization approval/disapproval of actions. Therefore, the influence of organizational codes seems to be limited to perceived organizational norms and not generalized to personal and coworker norms.

Accordingly, these findings suggest that organizations need to formulate appropriate codes that address specifically CT. The development of organizational codes is admittedly not an easy task (Barnes, 1990), but it can be done (Kaptein and Wempe, 1998; Creating a Workable Company Code of Ethics, 1990). Moreover, the current research suggests that such codes need to be integrated into the organization's normative structure. This might be accomplished by distributing the codes, discussing them with employees, and management using them in daily operations. If codes are used to guide behavior and to punish unethical behavior, they might be effective deterrents to unethical behavior (Cassell et al., 1997; Nijhof and Rietdijk, 1999). Thus, personal, co-worker, and organizational expectations will coincide to a greater degree and reduce the number of unethical actions. This is especially important since the results of this study show that individuals perceive differences in their judgements, co-worker judgements, and organization judgements in CT scenario actions. Training, which has always been associated with the notion of organizational formalization, should be conducted so that the individual, the co-workers, and the organization all have similar expectations about what is ethical behavior related to CT. Although differences in judgements between individuals with and without organizational codes were found, critics would perhaps observe that these differences were not as dramatic as might be expected. It must be recognized that organizational codes as well as CT specific codes are necessarily somewhat general in their statements and do not provide specific guidance for new situations that arise related to CT. As indicated earlier by the quote from Paradice (1990), the CT environment changes so rapidly that it is difficult to give a definitive statement of "acceptable behavior" and, thus, difficult to write specific codes for situations we cannot even anticipate. Also, it is possible that the level of understanding of these codes is not very high. Thus, the maximum benefit is not derived from organizational codes, leaving the individuals and co-workers to make ethical decisions with little external input.

It appears that an "external" code of ethics in itself is not completely sufficient to influence behavior. Behavior is only influenced when the individual internalizes the code as accepted normative behavior and believes that the company will enforce the code (Akaah and Riordan, 1989;

Skinner et al., 1988). In addition, Wyld and Jones (1997) suggest that a greater emphasis be placed on the development of the individual's decision-making process; thus, making them improved ethical decision-makers. Organizational codes can help by providing guidance in the decision-making process as well as state specific "rules".

Other studies (e.g., Robideaux et al., 1993; Pelfrey and Peacock, 1991; Barnes, 1990) suggest that organizational codes do make a difference in terms of influencing behavior. Moreover, company leadership ". . . can set the tone and create work environments in which computer professionals can express their ethical concerns" (Anderson, et al., 1993, p. 106). Thus, the expenditure of resources in terms of development, training, and enforcement of an organizational code appears justified and can project a positive image to the public, reduce "moral stress", improve the decision-making process, and deter situations for which the organization may be liable under current laws regarding CT.

Limitations

Two serious limitations of the study are as follows: 1) the to the potential for untruthful responses to an ethics questionnaire, 2) the presence of confounding variables related to codes of ethics in organizations. Addressing truthfulness of responses is a difficult problem. The only options in a mailed questionnaire seem to be assurances of anonymity and aggregation of data (which we did in this study) as well as careful wording of questions to avoid bias in the wording (which we also made every effort to do). On the other hand factors related to codes of ethics could be more carefully explored in a future study. For example a separate **analysis** could be done for employees with CT codes and those who have only general codes (Harrington, 1996). In addition, where there is a code, probing questions regarding the level of knowledge and understanding of the code, transmittal of codes, extent to which the code reflects a shared vision, and specific provisions of the code relate to the scenarios used in the study should be asked and responses used in the **analysis**.

Future directions

All of the limitations above might be used in designing future studies of the disparity in ethical perception within an organization. In addition an in-depth case study of one organization might reveal important patterns. Specifically a consequence of the current research, a strategy for organizations and future research consisting of three dimensions is suggested to increase the level of ethical behavior:

1) Formulate and use organizational codes with specific guidelines outlining behavior and consequences relative to CT; research the results.

2) Create an atmosphere where personal, coworker, and organizational norms of CT ethical expectations are congruent and complementary; assess the congruence of these norms.

3) Establish shared values related to CT, i.e., organizational norms guided by a formal code of ethics with provisions related to CT; determine the effectiveness of these efforts.

Acknowledgements

This research was partially funded by a Georgia Southern University Faculty Research Grant.

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Descriptors: Business ethics; Computer centers; Information professionals; Polls & surveys; Studies; Work environment
Classification Codes: 9130 (CN=Experimental/Theoretical); 2410 (CN=Social responsibilities); 5220 (CN=Information technology management)
Print Media ID: 15840

30/9/6 (Item 6 from file: 15)
02103655 65897686

Innovation and organizational change: Developments towards an interactive process perspective

Edwards, Tim

Technology Analysis & Strategic Management v12n4 pp: 445-464
Dec 2000
ISSN: 0953-7325 Journal Code: TAS
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 20 Pages
Special Feature: Table Chart Illustration
Word Count: 9872

Abstract:

Since the 1980s researchers have gradually revised the assumptions and research methods guiding their investigation of innovation. The ascendancy of processal perspectives, and more recently interactive process perspectives, in place of normative-variance perspectives, represents an shift in opinion. Scholars now contend that innovation is best understood as a dynamic, ongoing process during which actions and institutional structures are inextricably linked. Scholars adopting an interactive process perspective have however, largely ignored how innovation influences the reproduction of organizations, in part because the interactive process model is underdeveloped. This paper traces the demise and growth of different approaches in the study of innovation and develops an argument for why structuration theory would enable a significant advancement in the formation of an interactive process perspective. In doing so, a model of innovation as structuration process is developed illustrating how innovation can change the conditions governing the reproduction of an organizational repertoire. The modification of an organizational repertoire reflects the constraining and enabling aspects of the structural arrangements that simultaneously mediate and yet are an outcome of the actions of individuals involved in the innovation pose. This perspective is used to model the implementation of new products and processes in Alpha, a

medium-size enterprise in a Teaching Company Scheme Program.

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ABSTRACT Since the 1980s researchers have gradually revised the assumptions and research methods guiding their investigation of innovation. The ascendancy of processual perspectives, and more recently interactive process perspectives, in place of normative-variance perspectives, represents a shift in opinion. Scholars now contend that innovation is best understood as a dynamic, ongoing process during which actions and institutional structures are inextricably linked. Scholars adopting an interactive process perspective have however, largely ignored how innovation influences the reproduction of organizations, in part, because the interactive process model is underdeveloped. This paper traces the demise and growth of different approaches in the study of innovation and develops an argument for why structuration theory would enable a significant advancement in the formation of an interactive process perspective. In doing so, a model of innovation as structuration process is developed illustrating how innovation can change the conditions governing the reproduction of an organizational repertoire. The modification of an organizational repertoire reflects the constraining and enabling aspects of the structural arrangements (stocks of knowledge, resources, interests) that simultaneously mediate and yet are an outcome of the actions of individuals involved in the innovation pose. This perspective is used to model the implementation of new products and processes in Alpha, a medium-sized enterprise involved in a Teaching Company Scheme Programme.

Introduction

Innovation has meant different things to different scholars. At its most inclusive it has been defined to include 'the new markets, the new forms of industrial organization that capitalist enterprise creates',1 at its least, it has simply referred to a new object such as a computer.2 Increasingly, innovation in organizations is understood to represent 'the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order'.3 Such interpretations reflect a growing interest in the process through which 'new ideas, objects, and practices are created and developed or reinvented'.4 Hence, processual perspectives have come to focus on the social and economic activities 'encompassing various phases or episodic activities, recursively rather than sequentially related' through which different bodies of knowledge are constructed, communicated and exchanged.5

In reviewing the literature, King6 and Van de Ven and Rogers7 have suggested that much of the innovation literature is split between those studies that have used variance research methods and those that more recently have used process research methods. Wolfe8 suggests that the literature might be framed chronologically identifying how different methods have been shown to be conceptually and methodologically suspect gradually being replaced by other approaches: (i) diffusion of innovation; (ii) determinants of organizational innovativeness; and (iii) the innovation process. In contrast, Slappendel9 suggests that although reviews of this type provide insights into the literature they ultimately fail to 'expose the underlying theoretical assumptions about the role of individual action or structures'. Instead, she frames the literature according to the relative importance studies place on the role of individual action or structure. Three perspectives are identified and discussed in order of **historical** development and relative influence: individualistic, structuralist and interactive process.

Taken together these reviews seem to suggest an important trend. First, there has been a move towards the use of process research methods in place of variance research methods and second, it has become apparent to many scholars that innovation is a complex process (not static), produced by the interaction between structural influences and the actions of individuals.10 In the light of this, it is argued that a better understanding of the process of innovation in organizations will be served if a processual approach is couched in terms that treat action and structure as a duality rather than a dualism. Using insights from Giddens' structuration theory on the production and reproduction of social systems it is claimed that his notion of the duality of structure provides a metatheory that enables researchers to consider action and structure simultaneously.11 This is because 'structure', as sets of rules and resources chronically implicated in the organization of human conduct, provide the fundamental means for interaction and social construction. A structurational perspective of the process of innovation in organizations analyzes the way agents make use of the generative rules and resources incumbent of innovative processes in transforming existing institutional structures. Complementing this framework, Clark's work on organizational repertoires and poses12 is used to model the innovation process.

The interactive process approach developed in the first half of the paper is used to examine technology transfer between a medium-sized enterprise in the food industry and a University involved in a Teaching Company Scheme (TCS) Programme. This is not a new endeavour as there have been other studies that have merged processual approaches with a reconceptualization of action and structure in innovation13 and technology.14 Rather, this study proposes a framework that helps overcome the action-structure dualism that has undermined the explanatory utility of previous processual perspectives.

The term 'interactive process' is common in the field of innovation and has been used elsewhere to describe intra- and inter-firm innovative activities.15 In this paper, the term 'interactive' is used primarily to denote the re-formulation of the action-structure relationship although it does not negate the fact that TCS Programmes reflect both intraand inter-firm activities.

Researching Innovation in Organizations

It is generally accepted that the normative-variance approaches, typically of the late 1960s and 1970s, were 'inconclusive, inconsistent and characterized by low levels of explanation'.16 These failures undermined the positivist assumption that a theory of innovation would 'gradually emerge from the accumulation of more and more data'.17 Hence, in place of past certainties about scientific method scholars began adopting processual methods. These have developed from simple linear stage models18 to those that include notions of recursivity, multiplicity and feedback loops.19 In turn, as scholars try to unpack the complexities of innovation, it has become apparent that explanations need to account for the interactivity between action and structural orders.20

Variance theory building is concerned with identifying causal links between variables that conform to the view that 'the precursor (X) is a necessary and sufficient condition for the outcome (Y)'.21 In this way, a key variable (e.g. earliness of innovation, extent of innovation, presence/absence of innovation) is tested against 'contributory conditions' (e.g. motivation and resources), which have their own variance: 'the level of innovation is a function of the levels of motivation and resources'.22 Scientific explanations based on variances has proven illusive in the social realm 23 and reflects the view held by many that the search for universal laws in the social sciences is a 'chimera'.24 It is perhaps unsurprising then that prediction has seemingly been impossible to achieve.

Complexity relates to the numerous and **random** interactions between variables and the conditions contingent upon each individual study. The main problem has been to provide a variance theory that can account for this complexity:

The ability to make the kinds of generalizations and predictions that are typically associated with science and models is consistently being undermined by the phenomenon of complexity.25

Such a theory has been elusive because 'virtually every determinant employed has proved to be a highly and inexplicably erratic predictor of innovativeness with an impact that varies dramatically across studies'.26 The problem with predictability and variance research methods also rests on the dependency of unrealistic interpretations of other contributory conditions. Van de Ven and Rogers27 state that many variance studies 'could not effectively investigate how organizational structure affected innovation' because 'structural variables were not very adequately measured, nor could they be accurately operationalised'. While Wolfe,28 observes that variance studies have relied too heavily on an invariant perspective of innovations that has ignored changes in the innovation during the innovation process.29 Equally problematic is the limited role variance approaches ascribe to individuals in communicating meaning or knowledge about the innovation. Swan30 argues that when diffusion and determinant studies (using variance approaches) are drawn upon to investigate the implementation of 'best practice' knowledge, they wrongly assume that (i) individual cognitions only play a small role in technological innovation and (ii) individuals are relatively passive when receiving new ideas. Hence, these studies fail to account for the way individuals are 'actively involved in the construction of the knowledge base'.

According to Slappendel,31 interest in process perspectives gained popularity following the publication of the critical essays by Downs and Mohr.32

Process theory research of organisational innovation investigates the nature of the innovation process; how and why innovations emerge, develop, grow, and (perhaps) terminate, are examined. The unit of **analysis** of process theory research is the innovation process itself.33

Wolfe34 suggests that there have been two generations of process theory research. An earlier generation termed stage model research35 which characterizes innovation as a series of stages unfolding over time, and a later generation, known simply as process research.36 The latter approach describes the conditions and sequences which determine innovation processes and holds particular favour at present because it coincides with current views that innovation is usually a complex iterative process which is not linear and, as such, not best represented by sequential stage models.37

Mohr38 views process theories as primarily concerned with accounting for the complex inter-relationship between the necessary conditions, probabilistic processes and external discretional forces that influence innovation. Instead of explaining innovation in terms of 'efficient causes' and 'co-variances' the objective is to account for the probabilistic rearrangement of discrete states or events over time.

... some events and states may relate directly to the purposive actions of individuals, while others may emanate from external structural influences. However, in attempting to generate theories that will specify the conditions under which these multi-level events will join or separate, there is an implicit need to address the complex, and paradoxical,

relationship between action and structure.39

In the main, studies of innovation in organizations have taken one of three approaches concerning the relative importance of action and structure:

The deterministic structural model has captured the most attention; i.e. structure and context cause innovation. Alternatively, member values and attributes can be cast as the primary rival causal force in determining organisational innovation; i.e. elite values favourable to change best predict organisational innovation. Finally, the relationship between organisation and innovation may be interactively influenced by both structure and membership.40

In adopting a processual approach the task is to reconcile those perspectives that have favoured either individualistic or structural biases. Such approaches have however been flawed because they have relied upon variance research methods. An individualist perspective is primarily concerned with the action of individuals. These actions are not believed to be constrained by external factors rather they are believed to be the outcome of self-- directing agents who are capable of introducing change in organizations. This is a 'trait approach' to innovative behaviour that equates the innovator's characteristics, age, sex, education, values, personality, goals, creativity and cognitive style with organizational innovation. The structuralist perspective assumes that innovation is determined by organizational characteristics such as centralization, complexity, formalization, size, strategy and goals. Central to this perspective is the notion of determinism, where it is thought that organizational behaviour is shaped by external constraints.41 Both perspectives have been criticized: the individualist perspective is believed to be mistaken in assuming that innovative decisions only involve single individuals or that individual characteristics are not affected by organizational role. The structuralist perspective is criticized for the way it assumes that organizational features are objective realities.42

The task of reconciling action and structure is what defines an interactive process perspective. Van de Ven and Rogers43 suggest four ways of reconciling agency and structure: (i) acknowledging the deterministic and voluntaristic aspects of social systems, (ii) clarifying the connections between the various levels of **analysis**, (iii) link action and structure with different temporal stages, (iv) develop new theories of the action-structure relationship. The approach adopted here utilizes new theories of the action-structure relationship (i.e. structuration theory) in developing an interactive process perspective. This is not without its own controversies as structuration theory has been criticized on many fronts.44 Nonetheless, it is proposed that structuration theory provides useful sensitising devices to develop the notion of interactivity.
Developing an Interactive Process Perspective

The adoption of an interactive process perspective reflects a dynamic interpretation of innovation in organizations appreciating the 'societal filere of institutions' and their context dependency. It is built on the following assumption:

that individuals as active human agents are both influenced by pre-existing forms of structuring, yet are to some degree empowered to interpret what should be done in the future.... The theory of structure and agency presumes that individuals learn a collective repertoire of cognitions, normative frameworks and behavioural patterns.45

According to Giddens, 'structure' in social **analysis**gt; refers to the rules and resources drawn upon and enacted by agents in the production and reproduction of social systems. Structure provides the

binding of social practices into social systems that are 'both constraining and enabling in respect of human action'.46 This forms Giddens' concept of the duality of structure:

Analysing the structuration of social systems means studying the modes in which such systems, grounded in the knowledgeable activities of situated actors who draw upon rules and resources in the diversity of action contexts, are produced and reproduced in interaction.... The constitution of agents and structures are not two independently given sets of phenomenon, a dualism, but represent a duality.47

All institutionalized practices of social interaction, according to Giddens, involve four structural properties: (i) rules pertaining to the constitution of meaning; (ii) rules pertaining to normative rights, obligations and sanctions; (iii) allocative (material) resources; (iv) authoritative resources. Rules are considered to be at the core of the 'knowledgeability' of agents; they are the techniques and procedures applied in the enactment and reproduction of social practices. Resources are the facilities drawn upon by agents, organized as properties of social systems. Given these characteristics of structure the **analysis**gt; of properties in any given social system will yield three analytical configurations (Figure 1):

(i) structure of signification (semantic rules);

(ii) structure of domination (authoritative and allocative resources); and

(iii) structure of legitimation (normative rules and resources).48

The signification structure provides actors with a number of interpretative schemes or standardized stocks of knowledge to communicate the reality of their actions in the production of interaction. According to Giddens49 they 'form the core of the mutual knowledge whereby an accountable universe of meaning is sustained through and in processes of interaction'. The signification structure is supported by the legitimation structure (and vice versa) that binds agents' actions according to the accepted norms regulating and sanctioning interaction. These systems of moral rules stress the inter-play of norms and sectional interests illustrating the way power is implicated in social action. Giddens conceptualizes power as 'transformative capacity' chronically implicated in human agency. However, this 'notion of power has no inherent connection with intention or will'. Consequently, the 'use of power in interaction thus can be understood in terms of the facilities that participants bring to and mobilize as elements of the production of that interaction, thereby influencing its course'.50

Figure 1.

These structures have no reality except in the way they are instantiated in activity or retained mentally as remembered codes of conduct or rights to resources but they are central to structurational accounts of social order.51 The main difference between this form of **analysis**gt; and those of a voluntaristic or deterministic type is that action and structure are considered simultaneously. Hence, the route to explanation and therefore the focus of **analysis**gt; centres on the reproduction of social systems:

The basic domain of study of the social sciences, according to the theory of structuration, is neither the experience of the individual actor nor the existence of any form of societal totality, but social practices ordered across space and time.52

Thus, innovation is not seen to be the result of freely participating individuals nor is it believed to be dependent on some objective

characteristic of the organization, rather, it reflects the continuity or modification of those rules and resources that mediate and are an outcome of human conduct in an organizational setting. Knowledge about the conditions of system reproduction can be reflexively used by actors to maintain, influence, shape or modify those organizational orders. In particular, agents have the 'potential to choose actions deliberately, and to carry them through effectively, even in defiance of established rules and prevailing powers'.53 Hence, the innovation process represents the intersection of the structures of signification, legitimation and domination instantiated in a network of social relations, which cross the pre-existing 'organisation[al] operating systems, environment, **historical**gt; and cultural systems as well as the broader political context in which organisations operate'.54

According to Giddens, agents are understood to mobilize the modalities of structuration (interpretative schemes, norms and facilities) in the constitution of interaction. The modalities link the process of interaction with the structural components of social systems. Modalities can be studied in one of two inter-related ways. This reflects the distinction made, for methodological purposes, between the **analysis**gt; of strategic conduct and institutional **analysis**gt;. The first method of studying modalities would be to study the methods in which actors draw upon and mobilize the structural elements (rules and resources) in their social relations. The methods of mobilizing the modalities in a system of social interaction are linked to the establishment of arrangements that regulate the social system. Giddens terms this methodological procedure the **analysis**gt; of strategic conduct: 'social **analysis**gt; which places in suspension institutions as socially reproduced, concentrating upon how actors reflexively monitor what they do; how actors draw upon rules and resources in the constitution of interaction'.55 The second way would be to analyse modalities as a feature of a system of social interaction. In this way, institutional **analysis**gt; places an epoch upon strategic conduct (where the skills and awareness of actors are placed in suspension) so that attention is given to 'treating institutions as chronically reproduced rules and resources'.56 This bracketing is significant because at one level of **analysis** attention is given to the specific activities involved in system reproduction (action) while at another level (second order) the **analysis** concentrates on explicating the structural properties that mediate and are an outcome of social and cultural reproduction. Thus, the orthodox view of focusing on the seller of innovation and assuming that technology is 'stable' and unproblematic is revised. Instead, the innovation process is seen as inherently uncertain reflecting social interactions between competing groups involved in the introduction of new practices and routines (both technological and organizational dimensions) that maybe temporary or reinterpreted thereby reinforcing or modifying institutional arrangements.57

The notion of interactivity outlined above forms the basis of the following case study **analysis**. However, before I move onto the **analysis** it is necessary to provide a framework to detail the organizational changes linked to innovation.

Organizational Repertoires and Transformation

The notion of 'organizational repertoire' is adopted to represent the company specific knowledge which co-ordinate (i) everyday activities, (ii) activities associated with change and (iii) activities undertaken in response to special situations.58 These will consist of a range of actions which come into play at different times and places and may vary to the degree they are sedimented in a company's operational units. In this way, organizational repertoires consist of combinations of 'poses' depending on

the circumstance. Organizations will adopt differing 'poses' in certain situations,59 for example, when an organization is in the process of handling the 'introduction of different forms of operating ... which orient the adaptive capability [of the organization] towards future problems' it is likely the organization will adopt an innovation pose in conjunction with its basic operating pose.60 Thus, organizations may, at certain times, undertake an array of 'poses' involving different actors from a range of productive units. As illustrated in Figure 2, the introduction of an innovative product or process may effectively transform the existing basic operational pose of the repertoire. Moving from the top left corner to the bottom right corner the diagram illustrates the multiple activities associated with innovation in an organization-the attempted transformational and ongoing activities associated with the usual provision of services and products.

Change in the repertoire (partial or total) through innovation is not guaranteed rather, it is inherently uncertain. It represents an attempt to alter the organization-specific practices previously embedded over time in its operating procedures. New practices may be compromised because of resistance or problematized because of an absence of the necessary knowledge to make sense of and operationalize the new procedures and equipment. Therefore, an investigation of transformational change is dependent on showing how the existing features of the repertoire, expressed through a particular operational pose embedded in the organizations social and economic context provides the means to undertake these new activities. This is achieved by making sense of the uncertainty that may surround the diffusion and adoption of an innovation. Uncertainty, is in two parts (see Figure 2).

Figure 2.

... the degree of uncertainty embodied and embedded within an innovation, and the extent to which users already possess levels of knowledge and skill which enable them to systematically encode the uncertainty and to devise means for handling its level.61

An organization's ability to deal with this uncertainty depends in part on those skills, resources, rules, normative frameworks and knowledge that define the organization and allow it to undertake some actions and not others. Thus, it depends on the extent to which the innovation can be unpacked and the extent to which individuals have the necessary skills and knowledge to do so. Organizational innovation and the transformation this represents reflect the appropriation of an innovation 'template'. The notion of template is used to encapsulate a special case of situated practice and habitus such as those found in weddings and sports.

Each of these consists of a replicable sequence of actions derived from a known generative pattern which is sufficiently articulated, embodied and portable to be utilised by competent bearers of the template when they and their constituency require. Templates are generalised cognitive frameworks used to impose an orientation on action and to give those actions legitimacy and meaning in some particular domain. Templates cue and are cued by affect and behaviour.62

The templates exhibited at weddings and sports are usually tight. However, templates can change depending on the particular context within which they are introduced. For instance, the exportation of rugby union from Britain into America, with its subsequent transformation into American football.63 Transformation of existing activities in line with the introduction of the innovation template represents the activation of an innovation pose; which may result in the gradual adaption of the basic operating cycle pose (Figure 3).

In order to provide an explanation of transformational change from an interactive process perspective, it is necessary to explain how the social practices associated with the innovation pose (organized around a template) and organizational repertoires are first, reproduced (strategic **analysis**) which may result in the modification of the basic operating cycle and second, identify the structural properties (rules and resources) or institutionalized features that actors make use of in the reproduction of the organizational repertoires, including those from the innovation pose (institutional **analysis**). Appreciating the innovation process in terms of structuration means identifying those moments of re-structuration. Transition or re-structuration represents the mobilization of those 'structural properties' instantiated in the innovation pose alongside or, in radical innovation, instead of those from the basic operating pose. The success of such endeavours is never certain.

Methodology

The empirical data is taken from a case study of the UK's Teaching Company Scheme (TCS). Each TCS Programme employs one or more graduates (known as TCS Associates) working in a company for at least two years part-funded by a government grant to the academic partner and supervised jointly by academics and industrialists on a project which is central to the company's strategic needs. TCS operates to enable academic and industrial communities to collaborate in mutually beneficial activities where certain elements of risk are shared through government intervention and funding. This case study is one of a series (six) that have been part of a PhD project looking at the innovation process in companies collaborating with higher education institutions in TCS Programmes. Utilizing longitudinal qualitative methods (processual), based on in-depth interviews, direct observation and detailed **analysis** of official documents and minutes from meetings, gathered at regular **intervals** during the two year period of the case study, it has been possible to provide a detailed account of the way a TCS Programme works in practice.

Figure 3.
Research into 'Alpha', a major player in the food industry, which has approximately 153 employees and is a subsidiary of Alpha Group, began in July 1997. Alpha in partnership with a University Chemical Engineering Department employing a single Associate have been working to develop a new range of products, processing methods and production capability. The TCS Programme at Alpha constitutes a range of tasks and activities that organize the transfer of skills and knowledge into the company. Adopting the terminology so far discussed, it provides an innovation template activated as part of the innovation pose.

The innovation template consists of a number of core administrative and management routines that ensure progress is monitored, changes to the template are tabled and agreed, budgets are tracked and future activities proposed. The substance of the template is found in the tasks that define and organize the activities of the Associate around a network of alliances. In this sense, tasks represent ensembles of individuals (including the Associate, industrial and academic supervisors), knowledge, skills, rules, resources and artefacts (technology). This forms a virtual generative pattern of activities that mediate (legitimize, sanction, facilitate) the innovation pose. It also represents the means through which uncertainty can be overcome. The innovation pose represents activities that are recursive and designed to develop a broad spectrum of knowledge and artefacts. In addition the innovation template enrols a range of skills and knowledge (Associate and academic supervisor), previously outside the company so to ensure the appropriation of those skills and knowledge relevant to solving the company's problem.

Although the innovation template may have a clearly defined set of tasks with a range of milestones and deliverables its implementation is not simple and linear, rather, individuals reflectively monitor progress according to a range of rules and resources that exist beyond the innovation template. This may reflect broader commercial issues or sectional interests in the company resulting in the re-interpretation of the original innovation template. At such times, or 'critical moments' the innovation process is contested and may result in its modification or even abandonment. The capacity to appropriate innovation reflects the conditions governing the reproduction of these institutional orders.

Transformation at 'Alpha'

The decision to seek funding and assistance from the Teaching Company Directorate was orchestrated by PA, the Project Director at Alpha. Prior to being the Project Director, PA had originally owned the site operating under the name of 'Flacom'. Shortly before the TCS Programme had been considered Flacom was sold to Alpha Group. The acquisition by Alpha Group represented an important strategic decision to diversify its core business since the market share of Alpha Group's primary business was being jeopardized by competition from the Far East and Asia. In doing so, it moved the core operating pose (activity) of Alpha (previously Flacom) to its main operations in Northumberland. This had significant implications for what was left of the original company. The successful bid for TCS funding and the anticipated development of the remaining products was essential for the future of the site.

The application for TCS funding represents a deliberate policy by senior management at Alpha-adoption of an innovation pose. First, although the technical staff at Alpha had plenty of experience of developing methods to extend current production activities, it was felt that additional assistance was needed if the new production process was to include improvements to product quality. This meant developing analytical methods to assess product degradation at each stage of the production process. Second, it allowed Alpha to undertake such work without overly extending capacity and **financial** commitment thereby minimising the level of risk. The systematic search for central government funding signalled the beginning of the innovation pose. This involved negotiations with Teaching Company Directorate representatives and, in time, detailed discussions with the academics. Hence, the adoption of the 'innovation pose' involved 'tapping the tacit and contextual knowledge of different individuals and groups' with the objective of seeking 'to identify potential network participants possessing relevant information and expertise'.64 The activation of the innovation pose began with the construction of knowledge and skills around a set of alliances and problems codified in the TCS proposal-- template.

The template was originally designed with three specific phases in mind. These are numbered sequentially for the purposes of **analysis**. In reality, these phases are not strictly sequential, instead they are concurrent and recursive: (1) Process design; (2) Analytical development; and (3) Production and manufacture. Phase 1 included three specific objectives (a) improve and develop the existing initial process for the current product range; (b) improve and develop the techniques used for the production of specific end products; and (c) develop a generic process-including (a) and (by-on a commercial basis to enable the production of products in a number of forms. Phase 2 included (d) improving and developing analytical techniques and methods for the identification and assay of specific characteristics of the component parts of the product; and (e) improving and developing analytical techniques and methods for the investigation and assaying of finished products. Phase 3 included (f) the

commissioning of the new plant including improvements in waste management and the impact of potential adverse processes on the environment.

The key patterns that emerged during the innovation process reflect substantial compromises to the original innovation template (as outlined above). In the case of Alpha, the innovation template as a set of rules and resources was gradually changed as extraneous elements undermined the relevance and appropriateness of certain aspects of the template. For the Associate, he was made aware at the start of the innovation pose (by senior management) that the development and implementation of the template had to be measured (sanctioned) against the company's need to rapidly increase its production of existing and new products. So although the Associate was initially given 'free reign' to address the three phases of the innovation template such actions were only supported as long as the design, procurement, instillation and commissioning of process equipment was completed as quickly as possible (Phase 3). This marks an important juncture in the activation of the innovation pose because it illustrates the significance of pre-existing structural principles that cross, mediate and inform decisions and actions. In particular, the need for a rapid scale-up of production conditioned the subsequent re-design of the production process (Phase 1) of the remaining operating pose. As the time aspect was key the existing processes remained basically the same precisely because these were proven and would require only minimal revision to deliver increased yield on existing and new products. Thus, although the Associate undertook more rigorous investigations into the design (Phase 1) and performance (Phase 2) of the production process of the remaining operating pose submitting a 'wish-list' of improvements (Phase 1); conditions outside his influence governed the translation of these in the innovation pose.

An Interactive Process Perspective

Translating the template depended on the Associate being able to tap the knowledge of Alpha's technical staff (on existing processes/market) and the academic's scientific and technical knowledge (on analytical methods and to a lesser degree production). Hence, the innovation pose is a social process involving formal and informal information exchange among the members of a social system.65 In this way, the Associate acted as a 'boundary spanner' connecting knowledge and skills via a wide range of inter and intraorganizational interactions translating them into local solutions.66

The conduct of the Associate is framed not only by tasks in the template but also by pre-existing organizational arrangements that are both enabling and constraining. It is perhaps unsurprising then that the template has not remained static, rather, the Associate and his supervisors have revised the activities and objectives. The revision to the template has been a somewhat contentious process with the concerns of the industrial supervisor (Project Director) taking precedence. This is perhaps to be expected given the TCS Programme is by definition a commercial endeavour. In brief, the Associate who was originally tasked with reviewing and developing the production and analytical processes of the remaining operating pose has actually focused on relatively minor improvements to the production process while the analytical work has been effectively marginalized. Transformation of the remaining operating pose has been partial because the conditions governing translation have remained inextricably linked to the pre-existing arrangements associated with Alpha's original core operating pose. Although the relocation of these activities provided the impetus for the TCS Programme it did not represent the abandonment of this operating pose, rather, only its physical relocation. In this sense, these original core activities still continued to influence decisions informing the structure of the organizational repertoire even though they were seemingly dislocated in time and space.

Figure 4.

The re-configuration of operations at Alpha and the subsequent award of TCS funds and employment of an Associate mark the start of the innovation pose (pt. 0 on Figure 4). To begin with, the Associate examined existing production processes identifying weaknesses and finding ways to improve them:

At the moment we can only produce, say, X Kilos of the product a week and I know why, because 1 looked at the equipment I know why it was put in, how it was put in, why it is used in that particular way, and then I have gone along and said well this is the slowest step that holds everything up.

Phase 1 was an essential part of the innovation pose because it provided the Associate with the necessary base knowledge to proceed with the design of a new generic production process. Familiarization with the existing operational pose was a necessary part of the innovation pose, achieved by conversing with technical and operating staff, shadowing operators and filling in if any were absent. The main output of this period (pt. 1 on Figure 4) was the Associate's 'wish-list' of new equipment and procedures (Phase 1) that would form the basis of the new production facility (Phase 3). In this period (the first 912 months of the innovation pose), the Associate also began to make provision for and commission the immediate scaling-up of the existing process (pt. 2 on Figure 4). This included moving the plant to a larger unit on the Alpha site to enable increased production, installing an oven to produce new products, installing a new boiler to ensure the increase in production capacity and a number of other features to improve robustness and efficiency (pt. 3 on Figure 4).

Although these improvements increased the plant's capacity they did not reflect any of the significant revisions to the original production process in the Associate's wish list (Phase 1); they did not change the basic configuration of the production process (which was inefficient) nor improve product quality (Phase 2). Any revision to the production process including improved quality demanded a detailed 'root-and-branch' **analysis** of the process (Phase 2). The seemingly 'premature' completion of Phase 3 reflected the dominant interpretations conditioning the actions of the Associate:

The reason for building it was if I had waited to have done the analytical work and say, for example, I had got it all working and knew exactly what was happening ... that means ... I would not get the equipment until this December [the end of the Programme]. ... So my reason for doing it was the absolute push because without the speed there was no company.

The scaling-up of the plant was not questioned (either by the Associate or the academic) because it was accepted that the site's survival depended, in the first instance, on successfully scaling-up the process. Nonetheless, the Associate was able to devote a significant part of his time, during the same 9-month period, on developing the analytical methods (pt. 4 on Figure 4). He began by investigating High Performance Liquid Chromatography (HPLC) as a means of establishing criteria to assess the degradation of active compounds in products at each stage of the production process. HPLC was a key academic input and would provide two direct commercial benefits: first, it would enable the company to assess scientifically the key characteristics of the production process, and second, it would add **value** to the end product by allowing the active compounds in each batch to be quantified providing a level of information on quality not previously available.

During the first 12 months the Associate accepted that his main priority was to scaleup production. Up to this point HPLC had been complementary to

these core activities, however, as the 'new' production site began to take shape (pt. 3 on Figure 4) a number of commercial decisions taken by Alpha Group significantly undermined the attempts of the Associate to implement the 'wish-list' or quality improvements. In particular, Alpha Group decided to switch Alpha's original production activity (pre-TCS) back to the site (pt. 5 on Figure 4). This was a 'critical moment' in the activation of the innovation pose because it marked the re-appropriation of the previous core-operating pose in Alpha thereby forcing the Associate to reassess his interpretation of the future direction of his work:

I think because [PA] now has [activity A] back on site, [activity B] will pretty much cease to be produced or researched in anyway apart from what I do. Because HPLC is not essential for [activity A] work, and because I think [PA] sees 95% of products being [activity A], what is the point in developing a very expensive analytical process or even buying a new HPLC when you are not going to use it very much? But my perception of it is because [PA] sees the site as a [activity A] production site primarily it is not an essential piece of kit.

Not only did these events undermine the Associate's ability to justify his continued work on HPLC (the Associate spent 3 months working solely on re-appropriating the core activities) they also played an important part in re-orientating the industrial supervisor's interpretation of the whole innovation pose especially Phase 2:

[PA, the industrial supervisor] essentially said that HPLC was not essential for the evaluation of the extraction process, which I think is wrong ... I would consider it to be pretty essential.

Following the re-appropriation of Alpha's original core operating pose the Associate was taken-off work on HPLC and was told to assess the process simply on the basis of total extractables (yield) and not on the individual components:

I am now spending every other week at the University essentially looking at extraction with no HPLC whatsoever in any part of the research.

For the Associate the final 8 months of the innovation pose were effectively spent in the laboratory working on simpler analytical methods (pt. 6 on Figure 4) while Alpha reverted to the manufacture of the re-appropriated products relegating the other activities to the periphery of operations (pt. 7 of Figure 4). These events shaped and modified the activities of the Associate during the innovation pose. The provisional conclusions that can be gained from these findings concern the way the activities of the Associate reflect the changing relationships between the key players in the activation of the innovation pose. As has been shown the appropriation of the template depends on a range of elements that shape the worldviews of the network participants. At the beginning of the innovation pose there was general agreement among the participants (Associate and supervisors) that the innovation template should be introduced in full. This held true for the first 9-12 months of the Associate's work as a compromise between the need to scaleup production and the development of analytical methods could be easily justified given the success of the Associate in installing the 'new' plant (pt. 1-pt. 3 on Figure 4).

However, with the re-appropriation of what was Alpha's original core operating pose (pt. 5 on Figure 4) the key players were confronted with 'new' conditions. As it turned out, the industrial supervisor relative to their positioning in the network was able to reformulate the alliances in-line with the commercial 'realities' faced by Alpha. What had always been the defining interpretation of the template was used to modify the template so that 'local' definitions pertaining to the commercial integrity

of the site (in this case by the industrial supervisor justifying re-appropriation) were used to lever the activities of the Associate towards new challenges and objectives. The configuration of relationships during this period seemed to reflect key inequalities in the translation of the innovation pose. This critical moment in the innovation pose illustrates the point at which a dislocation of interpretations occurred where the re-appropriation of the original core-- operating pose transformed the conditions governing the repertoire. In particular, it resulted in the effective marginalization (pt. 7 on Figure 4) and substitution of the innovation pose (pt. 5 on Figure 4). Thus, the innovation pose effectively ceased to transform the organizational repertoire. The Associate's work, from this point on, seemingly had little commercial **value** other than ensuring that orders were met (pt. 7 on Figure 4) and that some analytical work was undertaken to ensure an academic interest and output (pt. 6 on Figure 4). Hence, the Associate no longer acted as an effective boundary spanner (no links between pt. 6 and pt. 7 on Figure 4), rather, his activities reflected a schism where objectives had become dislocated according to factional interests.

Transformation is understood as transition from one form of structuration represented by the remaining operating poses) towards a 'new' pose, which may, constitute a major change in the original mode of structuration (repertoire). Given the apparent failed transformation at Alpha, it is important to make sense of the interplay between the structural properties mediating the organizational repertoire. As indicated, these reflect apparent asymmetries of power, conflicting normative frameworks and other features mediating the management and enactment of the innovation pose (Figure 5).

Alpha's organizational repertoire is mediated by multiple structural properties (constituting the poses) that have governed the continuity or transformation of the repertoire during the TCS Programme. The various poses (including the original operating pose) provided sometimes complementary and then ultimately contradictory rules and resources in its reproduction. The ascendancy of certain conditions was affected by specific events or critical moments. Such occasions map the dislocation and re-appropriation of different constructs of the organizational repertoire utilized by actors to interpret, sanction and legitimize their positions. In this instance, it provided senior management a rationale to re-interpret the original objectives of the Associate's work and effectively marginalize those activities to such an extent that transformation of the remaining operating pose was incomplete and temporary.

Figure 5.

In Figure 5, the re-appropriation of the original core-operating pose at Alpha illustrates this dynamic of the reproduction of the organizational repertoire. Prior to this critical moment the participants in the TCS Programme took their cues from the innovation pose; the ensemble of tasks, alliances, rules and resources. This provided a set of interpretative schemes to make sense of the day-to-day interaction of the Associate and to a lesser extent those of his supervisors (e.g. the academic supervisor continued to be a lecturer during the TCS Programme). In addition, these arrangements provided the sanctioning and access to a range of resources to enable the completion of the pose according to the template. The structural properties associated with the remaining operating pose at Alpha also provided cues for the activities of those on site because the company continued to operate while the innovation pose was being enacted. Thus, the organizational repertoire represents a stratification of institutional orders where actors (including employees) draw on multiple structures from multiple poses.
The shaded boxes in Figure 5 identify the dominant orientation of

structural properties (dark shading compared to light shading) drawn upon by actors in the reproduction of the repertoire. The subsequent critical moment initiated the dislocation of cues between poses illustrating the affect of new conditions governing the reproduction of the repertoire. Hence, certain poses will appear to ascend to dominance in relation to others at varying times. As it turned out, the original core-operating pose had not been eliminated from the repertoire, rather only temporarily discontinued. With its re-appropriation, the conditions governing the reproduction of the repertoire were effectively called into question and transformation curtailed. Following the line of shaded boxes it is possible to distinguish between the different orientations of the reproduction of the repertoire. Hence, the innovation and remaining operating pose continued as part of the repertoire even if rather marginalized.

The Associate working closely with company representatives on site was subject to constraints not of their making. These factors represented a set of conflicting structural properties based on the immediate commercial concerns of Alpha Group. Ultimately, the industrial supervisor might have resisted the return of the original core-operating pose, but his main concern had always been the survival of the site and this could be assured with its re-appropriation. This situation illustrates the pivotal role of the Project Director who was a skilled manager able to define the 'rules-of-the-game' ensuring that the interests of the Associate reflected those of 'Alpha'. The norms regulating the actions of the Associate were always premised on the commercial concerns of Alpha. As shown, these were interpreted in various ways although within the period of re-appropriation a dislocation of rules and resources resulted in the reformulation of the organizational repertoire along the lines of the pre-TCS period. In maintaining a narrow system of moral rules the Project Director was engaged in establishing a specific set of interests; illustrating the way power is implicated in social action. The 'premature' design and instillation of the new production process and the effective marginalization of the analytical work illustrate the asymmetries of power in the social relations of the network participants. In these instances, the industrial supervisor by virtue of his position at Alpha and by virtue of the commercial discourses used to inform decisions in the organizational repertoire was able to redefine objectives and activities as legitimate in the light of the 'realities' afflicting Alpha.

Conclusion

This paper offers an **analysis** of organizational innovation based on an interactive process perspective. It couples an **analysis** of the strategic conduct of those players involved in the TCS Programme at Alpha with an investigation of the rules and resources chronically implicated in the production and reproduction of the organizational repertoire. Transformation from one mode of structuration to another has been shown to be inherently complex and unpredictable. This is because the instantiation of new structural properties (rules and resources) occurs at a critical juncture where the existing institutional orders mediating the actions of managers and employees alike are called into question. An **analysis** of the interplay of differing structural properties during the innovation process provides an important development in explaining transformation at Alpha. Instead of putting failure down to the vagaries of the market place which Alpha could not ignore, I would contend that the decision not to follow through with the innovation pose was politically motivated, presented as it was as a fait accompli to the Associate and academic supervisors. If purely commercial concerns had informed the decision then surely the real opportunities made possible by the TCS Programme would not have been dismissed in the way they were?

In Alpha, the implementation of the innovation template was compromised by

the decision to re-appropriate the site's original core-operating pose. This marked a stricture in the activation of the innovation template. Hence, those structural properties that had mediated and were an outcome of the activities of the Associate up until that point were suddenly subject to contradictory perspectives deployed by the industrial supervisor. Appreciating the innovation process from such a perspective enables us to show how the reproduction of the organizational repertoire was contingent on antecedents identified as the original core operating pose which once re-appropriated seemingly undermined the legitimacy to complete the innovation pose.

An advantage of adopting the interactive process perspective is the way the politics of organizational activities is made transparent and set at the centre of the **analysis**; a chronic element that is integral to understanding the dynamics and contingencies of the process. For example, even though TCS Programmes are organized around formal management systems these did not provide an adequate forum at Alpha for the Associate to effectively question the decisions of the industrial supervisor. From this it is clear that organizational politics is a defining aspect of the innovation process.67 In particular, the activation of the innovation template only remained legitimate as long as it coincided with the narrow concerns of the industrial supervisor. I would suggest that failure to adequately meet the concerns of the Associate via these management procedures reflects the pervasiveness of the political process throughout the Programme. This suggests that the formal management procedures were used as part of the political process to assert certain views at the expense of others: as long as the Alpha site could show a profit and these could be tabled at formal management meetings and linked (no matter how tenuously) to the TCS Programme then the upheaval associated with re-appropriation could go on without any serious questioning by the TCD consultant. Ultimately, TCS Programmes are judged on their contribution to profitability. Given this, as long as profitability could be 'shown' to be attributed to activities linked with the Associate (during the Programme) rather than the other 'softer' issues (e.g. the development of the Associate), which were of vital importance to the other network participants, could be explained away as a causality of commercial necessity. This **analysis** illustrates how structural properties can be changed by agents in positions of authority thereby altering the basis upon which the organizational repertoire is mediated and reproduced (see Figure 5).

I would contend that if TCS, as a mechanism of technology transfer, is to deliver the **value**-added associated with the involvement of academic institutions and Associates then closer attention needs to be given to those 'political processes' that mediate its activation and assessment. It was not enough to pay 'lip-service' to the problems facing the Associate nor was it appropriate to ignore these softer issues even if profits were improved. Instead it was the responsibility of the other network participants to establish 'working' relations so that healthy debate was allowed to take place. At Alpha, this debate seems only to have happened before Alpha Group decided to relocate Alpha's original activities. Many of the contentions (post re-appropriation) outlined in this paper were gathered in the knowledge that the concerns and ideas offered by the Associate during the research never really held any currency at Alpha once re-appropriation had begun. This is not because his ideas were commercially unsustainable rather it was because the innovation template, as a set of rules and resources, no longer complemented those worldviews of senior management at Alpha.

Although the observations made here relate to a single case study the implications are far reaching: transformation is a dynamic social process reflecting shifting influences of different interest groups. The evidence

serves to show that the skills and knowledge embedded in the organizational repertoire can be incredibly difficult to transform especially if they retain legitimacy. Innovation networks are the terrain upon which different interpretations and interests are negotiated. At Alpha, the Associate did eventually spend some time in the lab, although it was too late to develop his HPLC method. It would be easy to suggest that greater contact between the Associate and the TCD consultant would have helped to 'iron-out' such problems. However, one suspects that this did not happen because the Associate did not feel confident to confront his 'wouldbe' employers with suggestions that had been relegated to the waste paper bin. Once again, the politics of innovation seemingly pervade the organizational setting within which actors populate, constraining in this case, the decisions and actions of the Associate. I would argue that an interactive process perspective provides a framework that shows how the accomplishment of innovative activities (action) depends on the mediations constituting the contingencies of the institutional setting (structure). This marks a significant departure from normative-variance and simple process models because it focuses on the dynamic contingent specificity of the innovation process, including the antecedents. In doing so, it calls into question rational approaches that have ignored organizational politics. Hence, this **analysis** 'prises-open' the underlying mechanisms that enable or constrain innovation.

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Geographic Names: United Kingdom; UK

Descriptors: Organizational change; Organization development; Innovations
Classification Codes: 2500 (CN=Organizational behavior); 9175 (CN=Western Europe)
Print Media ID: 11856

30/9/7 (Item 7 from file: 15)
02096948 65261313

Implementation of an option pricing-based bond valuation model for corporate debt and its components

Barth, Mary E; Landsman, Wayne R; Rendleman, Richard J Jr
Accounting Horizons v14n4 pp: 455-479
Dec 2000
ISSN: 0888-7993 Journal Code: ACH
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 25 Pages
Special Feature: Formula Chart Illustration Table
Word Count: 8885

Abstract:

The binomial option pricing-based bond **value** estimation procedure used in the study "Option Pricing-Based Bond **Value** Estimates and a Fundamental Components Approach to Account for Corporate Debt," by Mary E. Barth, et al, is described. A fuller set of details is provided to permit the model's implementation by others, including other researchers and **financial** statement preparers. Another aim is to enhance understanding of option pricing-based debt and component

valuation. Several examples are presented based on the binomial or two-state option pricing model to illustrate accounting issues associated with the **valuation** of corporate debt and its components.

Text:

INTRODUCTION

This paper describes the binomial option pricing-based bond **value** estimation procedure used in our study, "Option Pricing-Based Bond **Value** Estimates and a Fundamental Components Approach to Account for Corporate Debt," (Barth et al. 1998). That study provides evidence on the relevance and reliability of option pricing-based **value** estimates for bonds and their components, i.e., conversion, call, put, and sinking fund provisions. Although the prior study provides a brief overview of the model's implementation, i.e., how to estimate total bond and component values, the objective of this paper is to provide a fuller set of details to permit the model's implementation by others, including other researchers and **financial** statement preparers. We also aim to enhance their understanding of option pricing-based debt and component **valuation**.

To achieve our objective, we present several examples based on the binomial or twostate option pricing model of Cox et al. (1979) and Rendleman and Bartter (1979) to illustrate accounting issues associated with the **valuation** of corporate debt and its components. In contrast to the Black and Scholes (1973) (hereafter the Black-Scholes model) and related option pricing models derived using the mathematics of stochastic calculus, the binomial model is derived using elementary algebra. Because of its simplicity, the model often is used to illustrate general principles of **valuation** to students and practitioners who have neither the interest nor the expertise to deal with the technical details of calculus-based **valuation**. However, when parameterized with appropriate inputs, the binomial model is a powerful numerical procedure for valuing options or securities with option-like features, and it tends to be Wall Street's model of choice for pricing complex option-like securities for which closed-form solutions cannot be derived.1

Present U.S. Generally Accepted Accounting Principles (GAAP) require that corporate debt, in the aggregate, including all of its components, be recognized as a liability. However, as we explain in our prior study, each debt feature represents an option controlled by either the bondholder or the firm. Accordingly, a particular feature can have liability, asset, or equity characteristics. For example, conversion features of corporate debt are options of bondholders that permit them to exchange the bonds they hold for equity per the bond contract. This call on the firm's equity can be viewed economically as a form of equity similar to warrants and executive stock options granted by the firm. Call features are options of the firm and have asset characteristics in that such options have the potential to bring the firm future benefits. These benefits result from the firm's ability to retire its debt at an amount less than that it would otherwise have to pay. Sinking fund features represent a call on a portion of the bond and at the same time also serve to reduce bondholder risk, making their characteristics firm- and issue-specific.

The **Financial** Accounting Standards Board (FASB) currently is considering requiring separate recognition of corporate debt components, which the FASB refers to as a fundamental components approach (FASB 1990, 1991). International Accounting Standards (IASC 1996) and Canadian GAAP

(CICA 1995) already require that conversion features of convertible debt be recognized as equity. Findings in our prior study indicate that debt component **value** estimates represent large fractions of bond **value**, and a fundamental components approach to account for corporate debt results in key **financial** statement amounts significantly different from those presently recognized. This paper describes a procedure that can be used to obtain component **value** estimates.

For debt with no option-like components, there may be little benefit associated with using option-based **valuation** techniques when market values of debt are observable. However, most debt issues are not publicly traded and, thus, do not have observable market values. Moreover, even if market prices for bonds with option-like components are observable, generally market values for their components are not. Option pricing-based techniques can be used to estimate values for bonds and their components regardless of whether bonds are publicly traded.

The remainder of this paper is organized as follows. The first section develops the binomial model in general form. The second section extends the model to the **valuation** of corporate debt and debt components, followed by a discussion of implementation issues in option pricing-based bond **valuation**. The third section illustrates the application of the model to the **valuation** of debt issued by Boise Cascade Corporation. The final section provides concluding remarks.

THE BINOMIAL MODEL

Cox et al. (1979) and Rendleman and Bartter (1979) derive the binomial option pricing model using no-arbitrage **valuation** principles, similar to those in Black and Scholes (1973). They also demonstrate that binomial option values converge rapidly to those of the Black-Scholes model when the life of the option is partitioned into a large number of binomial time periods.2

In the binomial model, it is assumed that the underlying asset on which the price of an option is based can increase in **value** from one binomial period to the next by a factor of u times its previous **value** or decrease in **value** by a factor of d.3
Although u and d can vary with time, standard applications of the binomial model assume u and d are constant.4 In this paper and in most standard applications, the risk-free rate of interest to be earned over each binomial period, denoted as r, also is assumed to be constant. However, as in Barth et al. (1998), the interest rate can be specified as a function of time using the observed term structure of interest rates. To avoid riskless arbitrage, the binomial model requires that u > 1 + r > d in every period.

Figure 1 illustrates price movements in a "binomial tree" over two periods for an asset originally worth $100, with u = 1.5 and d = 0.5. 5 Each node of the tree is represented by a time and state indicator, (t, j), where t denotes time and j denotes the number of times the underlying asset has increased in **value**. The **value** of the asset in any state It, j is A

sub t,j

According to the binomial model, the present **value** of an option or option-like security in any state (t, j), denoted as H

sub t,j

is given by the following equation.
In equation (1), P

sub t+1,j+1

, is the price of the security in the up state at time t + 1 and P

sub t + 1,j

is the security's price in the down state. Throughout we refer to the security's present **value**, H

sub t,j

, as its hold **value**, because it represents what the **value** of the security would be if held rather than exercised by the owner or issuer. Examples of exercising include the decision of the issuer of a callable bond to call the bond before its scheduled maturity date, the decision of the owner of a convertible bond to convert the bond to common stock, or the decision of a firm's stockholders to allow the firm to default on its debt.6 It should be noted that if exercise is optimal, a security's price, P

sub t,j
, could differ from its hold **value**.7

FIGURE 1

In equation (1), pi is the risk-adjusted probability associated with an increase in the **value** of the underlying asset. Under conditions of risk-neutrality, pi is the probability that the up state will occur, but under more general conditions, pi is the true probability adjusted downward to reflect the degree of risk aversion jointly implied by the values of r, u, and d.8 Therefore, the hold **value** in equation (1) takes the form of a risk-adjusted expected **value** discounted at the risk-free rate of interest. Recognizing that binomial **valuation** takes this form is important in subsequent **analysis** of the mathematics of bond component **valuation**.9

In the binomial model, u and d are determined as functions of the volatility of the underlying asset and the length of time covered by a single binomial time period. Later we address the issue of how u and d are determined, but for the examples of corporate debt **valuation** that follow, we simply assume that the values of u and d reflect the anticipated volatility characteristics of the firm.

RECOMBINING AND NON-RECOMBINING BINOMIAL TREES

Before developing specific examples of binomial-based debt and equity **valuation**, it is instructive to demonstrate the difference between recombining and non-recombining binomial trees. A recombining binomial tree is one in which the **value** of the asset in a particular period is the same regardless of the order in which increases and decreases in **value** occur through time. In contrast, in a non-recombining tree values within the tree depend upon the order in which increases and decreases in **value** occur. Generally, when the binomial model is cast in a recombining framework security values can be calculated almost instantaneously using a relatively small amount of computer storage. However, when cast in a non-recombining framework, even small-scale **valuation** problems can take hours to compute and can require RAM storage beyond the capacity of most present-day computers.

Figure 1 illustrates a recombining binomial tree in which states within the

tree represent multiple outcomes. For example, state (2, 1) can result from the **value** of the asset going up and then down or from the **value** going down and then up. State (3, 1, not shown in the tree, can result from three different sequences of up and down **value** movements. As is evident from Figure 1, in a recombining tree there are exactly t + 1 possible outcomes for the asset **value** as of any time t. Thus, even if an option-like security is valued using many binomial periods (for example, 500 to 1,000), there are a computationally manageable number of binomial values in the calculation. In contrast, if the **value** of a security depends upon the order in which up and down **value** movements occur, there will be 2

sup t

possible binomial outcomes at any time t. Even for relatively small values of t, 2

supt

is very large. For example, for a 30-year bond priced using two binomial periods per year, one would need to calculate more than 10

sup 18

option values for the final period. Thus, **valuation** in a non-recombining framework can be impractical, particularly for long-lived bonds. As a result, when using the binomial model, assumptions are often made that allow a recombining tree structure to be maintained even though a non-recombining structure might provide a more accurate representation of the situation.

For example, assume that an asset worth $100 at time 0, returns $1.50 per $1 invested in each up state and $0.50 in each down state. However, in the first binomial period a cash payment is made from the asset that reduces its **value** by $6. 10 Figure 2 shows the evolution of the **value** of this asset over two binomial periods. The entries in Figure 2 show that reducing an asset's **value** by a fixed dollar amount in any binomial period causes the binomial tree to become non-recombining. Specifically, if the asset first increases in **value** and then decreases, its **value** at time 2 is $72. However, if the asset first decreases in **value** and then increases, its **value** at time 2 is $66. In contrast, if an asset's **value** is reduced periodically by a fixed proportion of its **value**, the binomial tree retains its recombining structure. Figure 3 illustrates the **valuation** dynamics for the same asset over two binomial periods if a cash payment equal to 6 percent of the asset's **value** is paid in the first binomial period. As we develop our examples of corporate debt **valuation**, we point out the assumptions that are made for the purposes of maintaining a recombining structure in **valuation**.

FIGURE 2

DEBT AND EQUITY **VALUATION** IN A BINOMIAL FRAMEWORK

In this section, we illustrate the binomial model for valuing corporate debt, starting with a simple debt structure and building to a more complex structure. Throughout, we

Zero-Coupon Debt

Consider a firm that has issued a single zero-coupon debt security along

with common stock or equity. The asset values in Figure 1 represent how the total capital **value** of the firm, i.e., debt plus equity, is expected to evolve in each binomial state over the next two periods. The question we address in binomial **valuation** is how much of the total capital **value** in each state represents debt and how much represents equity. Moreover, the binomial model enables us to show how the total **value** of debt relates to the values of its various features.

FIGURE 3

In this example, the debt matures at the end of the second binomial period and requires $60.00 to be paid to bondholders at that time. If the total capital **value** of the firm exceeds $60.00 at time 2, stockholders receive the difference between the total capital **value** and $60.00. However, if the firm's total capital **value** falls below $60.00, the firm defaults on its debt obligation, and the bondholders take over the firm. In such states, bondholders receive the total firm **value** and stockholders receive nothing.
It is helpful to think of the final debt and equity values arising from stockholders making the final debt payment out of their own pockets and, in return, obtaining 100 percent ownership of the firm's capital. Equivalently, the firm could issue additional debt and/ or equity securities that would have the effect of diluting the current stockholders' interest in the firm by the amount they would otherwise pay out of their own pockets. We assume that stockholders **finance** the zero-coupon debt payment only if it is in their best interest, i.e., only if the amount owed to bondholders is less than or equal to the **value** of the firm's total capital. This implies that the equity **value** in any state at time 2 is $\max(A_{2,j} - 60, 0)$ and that the corresponding **value** of debt is $A_{2,j} - \max(A_{2,j} - 60, 0) = \min(A_{2,j}, 60)$ Prior to time 2, debt and equity values are determined according to the binomial pricing formula of equation (1). Figure 4 shows how the debt and equity values evolve in each binomial state, with details of debt **value** calculations for states (2, 0) and (1, 0).

According to Figure 4, the time 0 binomial model-based debt and equity values are $47.99 and $52.01, respectively. Suppose observed market values are $46.00 and $54.00. An investor or **portfolio** manager who believes his/her estimate of the firm's volatility, as reflected in the values of u and d, is superior to the market's implicit estimate would conclude that the market **value** of the debt is too high and the market **value** of equity is too low. However, absent superior information about u and d, observing a significant difference between particular market and model values leads one to conclude that the volatility estimate used to determine u and d is incorrect and to adjust the volatility estimate.[11]

Valuing Straight Debt with Interest Payments

In this subsection, the zero-coupon bond pricing example is extended to include the payment of \$6 in interest at times 1 and 2. In this case, the firm owes its bondholders \$60 in principal plus \$6 in interest, i.e., \$66, at time 2 and \$6 in interest at time 1.

We continue to assume that stockholders **finance** the final debt payment, but in this case it also is necessary to determine how the \$6 of interest owed at time 1 is **financed**. One approach is to assume the interest is paid out of internally generated corporate funds. This would result in a \$6 reduction in firm **value** when the interest payment is made and, as illustrated in Figure 2, would cause the structure of the binomial tree to become non-recombining.

The recombining tree structure can be maintained by assuming that all debt payments are **financed** by the stockholders or, equivalently, by issuing additional capital that dilutes the **value** of current shares. This is the method of **valuation** suggested by Black and Scholes (1973) in the corporate liabilities section of their classic paper on option pricing, and would be the appropriate method of **valuation** for a firm that periodically "rolls over" its debt by raising new debt and/or equity capital to fund its outstanding debt obligations. We take this approach to **valuation**, recognizing that it tends to place a higher **value** on debt than if debt payments were **financed** internally.

From this point forward in our discussion, it is necessary to make a distinction between a bond's interest and principal payments. We denote a bond's interest and principal payments at time t as I_t and K_t, respectively. In this example, interest of \$6.00 is owed at times 1 and 2, but not at time 0. Therefore, $I_0 = 0$, I_1, $= 6$, and $I_2 = 6$. Also, \$60.00 of principal is owed at time 2, but no principal payments are owed prior to time 2. Therefore, K_0, $K_1 = 0$, and $K_2 = 60$.

As in Black and Scholes (1973), we assume that stockholders
finance each debt payment, but only if the **value** of
equity after servicing the debt exceeds what is owed to bondholders. Thus,
in any state, if the hold **value** of debt, H

sub t,j

, plus the total amount owed to the bondholders, K

sub t

+ I
sub t

, exceeds the total capital **value** of the firm, the firm will
default on the debt and turn the firm's equity over to the bondholders.
This implies that the post-debt service **value** of debt in any
state (t, j) is P

sub t,j

= min(H

sub t,j

+K

sub t

+I

sub t

,A

sub t,j
). In this and all subsequent formulations of bond values, H

sub 2,j

= 0 because there is no **value** associated with holding the debt
beyond its maturity date.

FIGURE 4

Figure 5 illustrates the pricing dynamics of the debt and equity, with
example calculations, and indicates that the time 0 debt **value**
is $57.50. Note that this **value**, when added to the $42.50 equity
value, gives the $100 total capital **value** assumed for
state (0, 0).

FIGURE 5

Valuing a Callable Bnn

In this subsection, we extend the previous example to include a call
provision that allows the issuing firm to call the bond at par, i.e.,
$60.00, at any time prior to maturity. However, even if the bond is called,
the firm must pay any interest that is owed to the bondholders.
We denote the price at which the bond can be called as of any time t as L

sub t

. In this example, L

sub 0

= 60, L

sub 1

= 60, and L

sub 2

= inf. (Setting L

sub2

= inf. ensures the bond is not called on its maturity date.) If the firm is not in default and acts in the shareholders' best interests, it will call the bond whenever the bond's hold **value** plus accrued principal payments exceeds the call price, L
sub t

, thereby buying the bond for L

sub t

when it is otherwise worth more. In addition, the firm must make any interest payments that have accrued to bondholders. This implies that the **value** of the bond in any state It, jJ is given by P

sub t,j

min(min[H

sub t,j

+ K

sub t

, L

sub t
] + I

sub t

A

sub t,j

). In this pricing expression, the inner-most minimum term reflects that the bond is called whenever the bond's hold **value** plus accrued principal payments exceeds the call price, L

sub t

. The outer-most minimum term reflects that the firm will default on the debt whenever its total capital **value** is less than the **value** of the debt plus interest owed.

Figure 6 illustrates the **valuation** dynamics of debt and equity for the callable bond, with example calculations. In this example, the **value** of the callable bond is $56.00. Compared to the $57.50 straight bond **value** from Figure 5, Figure 6 shows that the call feature reduces the **value** of the bond by $57.50 - $56.00 = $1.50. Thus, the firm's option to call the debt before maturity makes the bond less valuable to bondholders.

Valuing a Convertible Bond

In this subsection, we extend the example to include a conversion feature that allows bondholders to convert the bond into one new share of stock for every share of stock currently outstanding. Thus, upon conversion, the bondholders will own 1/1+1 0.5, or 50 percent of the firm's equity. In any state, if the bond is not converted into stock, accrued interest is paid to bondholders; if the bond is converted, accrued interest is not paid.13 To illustrate the interaction between call and conversion features, we consider two bonds. The first in Figure 7 is convertible but not callable; the second in Figure 8 is convertible and callable. In the second case, the firm has the right to call the bond at par, but after issuing a call, bondholders have an opportunity to convert the bond into stock.

In Figure 7, the bond price in each state is $P_{t,j} = \min(\max[0.5(A_{t,j}), H_{t,j} + K_t + I_t), A_{t,j})$. The maximum term within this expression reflects that the bond will be converted if its conversion **value**, $0.5(A_{t,j})$, exceeds the hold **value** plus accrued principal and interest. The minimum term reflects that the bond's **value** cannot exceed the firm's total capital **value**.

Figure 8 illustrates the pricing of the same convertible bond in Figure 7 with the addition of a call provision that allows the bond to be called at par at times 0 and 1. As with the nonconvertible callable bond in Figure 6 we assume that the bond is called whenever its hold **value** plus accrued principal exceeds the call price, i.e., when H

sub t

+ K

sub t

> L

sub t

. Whether called or held, bondholders are also entitled to receive accrued interest. Therefore, if the firm is not in default, and the bond is not converted to stock, the price of the bond in state (t, j) is min(H

sub t
 + K

sub t

, L

sub t

.) + I

sub t

. We assume that bondholders convert their bonds to stock whenever the conversion **value** exceeds min(H

sub t

 + K

sub t

),+ I

sub t
, a decision that reflects that bondholders are not entitled to receive accrued interest if the bonds are converted. These considerations, together with the possibility for default, result in the following price of the bond in any state (t, j): P

sub t,j

 = min(max[0.5(A

sub t,j

), min(H

sub t,j

 + K

sub t

,L

sub t

,) + I
sub t

], A

sub t,j

).

FIGURE 6

Bond values at maturity are the same in Figures 7 and 8. However, values in state 1, 1) are different in the two figures. The entries in Figure 7 indicate that without a call feature, it would not be optimal to convert the bond to stock in state (1,1). However, entries for the same state in Figure 8 indicate that the firm can call the bond and force conversion when, otherwise, conversion would not be optimal. Figure 7 shows that without the call feature, the bond would be worth $93.21 in state 11, 11. However, Figure 8 shows that the presence of the call feature forces the bondholders to convert to $75.00 worth of stock, because the next-best alternative is to have the bond called at $60.00 plus receive $6.00 in accrued interest. In addition, the bond is called in state (0, 0).

FIGURE 7
FIGURE 8

Comparing the **value** of $70.26 for the convertible bond in Figure 7 to that of the convertible, callable bond **value** of $60.00 in Figure 8 reveals that the call feature reduces the **value** of the bond by $10.26. That is, for this bond, the presence of the call feature greatly diminishes the incremental **value** of the conversion feature in determining the bond's **value**. Despite the presence of a conversion feature, the call feature results in a bond whose **value** is only $2.50 greater than the **value** of $57.50 for the straight bond in Figure 5. The pricing examples in Figures 7 and 8 illustrate the interdependence of call and conversion features. As discussed below, interdependence has important implications for separately valuing debt components.

VALUING THE COMPONENTS OF CORPORATE DEBT

We now turn to determining the **value** of each feature or component of the bond. Under the FASB's with and without method for **financial** instruments with multiple features such as bonds (FASB 1991), the **value** of a particular feature is determined by subtracting the **value** of the **financial** instrument without the feature from the instrument's total **value**. The with and without **value** of the conversion feature for the callable, convertible bond in Figure 8 is $4.00. This is computed as the bond's total **value** of $60.00 in Figure 8 less the **value** of $56.00 in Figure 6, which is the **value** of the same bond but with no conversion feature. Similarly, the with and without **value** of the call feature is -$10.26. This is computed as the bond's total **value** of $60.00 in Figure 8 less the $70.26 **value** in Figure 7, which is the **value** of the same bond but with no call feature.

As Barth et al. (1998) emphasize, when the sum of with and without component values of debt are added to the bond's straight **value**, the sum is not likely to equal total bond **value**. For the bond in Figure 8, adding with and without conversion and call values to the **value** of the straight bond of $57.50 in Figure 5 gives a

value for the callable, convertible bond of $57.50 + $4.00 - $10.26 = $51.24, which is $8.76 less than the bond's $60.00 total **value**. This non-additivity of component values occurs whenever component values are interdependent and either the **value** associated with the interdependence is ignored-as in the with and without method-or is arbitrarily assigned to more than one component. Note that component **value** interdependencies arise from the components themselves, not from any particular method of valuing them. Thus, any approach to account separately for debt components must consider their **value** interdependence.

The FASB has tentatively concluded (FASB 2000) that **financial** instruments with multiple features should be measured using the relative **value** method. As with the with and without method, component **value** estimates obtained under this method also are affected by component **value** interdependencies. Under the relative **value** method, fair values are estimated separately for each component without the requirement that the sum of the components' fair values equals the fair **value** of the entire instrument. Any difference is allocated to each component based on the component's relative fair **value**. This difference is assumed to arise from estimation error. However, any attempt to estimate separately component values also is subject to the problem of assigning the **value** associated with component **value** interdependence. Although, by construction, under the relative **value** method the sum of the component values equals the **value** of the entire instrument, the allocation of joint component **value** is arbitrary.

Using Probability Theory to Determine Values of Corporate Debt Components

In this subsection, we employ basic laws of probability theory to provide a framework to account for the **value** of corporate debt and its components. As noted earlier, the binomial **value** of a security in any state (t, j) is equal to its risk-adjusted expected **value** discounted at the risk-free rate of interest. Although the risk-adjusted expected **value** is computed using risk-adjusted or risk-neutral probabilities rather than true probabilities, the laws of probability still apply in the interpretation of binomial **valuation**.

Figure 9 illustrates interdependent probabilistic events A and B, each of which is represented by an oval in the diagram. The area inside the two large ovals represents the probability, pr, of event A or event B and is represented mathematically as:

Accounting for Component Values

Figure 10 provides two representations of debt component values based on the probability relations described above and the **valuation** of debt with various combinations of call and conversion features illustrated in Figures 6 through 8. The diagram in Panel A of Figure 10 indicates that the total **value** of the callable, convertible bond is $60.00. It also shows that the **value** of the bond with only a conversion feature is $70.26. We refer to this as the **value** of the pure convertible bond. Similarly, the **value** of the pure callable bond is $56.00.

FIGURE 9

Panel A depicts the with and without values of the conversion and call features, $4.00 and -$10.26, respectively. The area representing the intersection of the conversion and call values indicates the bond is worth $66.26 if the only time it can be converted is when it is called, or called when converted. That is, the interdependence of the two features arises

from the potential for the bond to be simultaneously called and converted. In the unlikely event that the bond were only convertible at times when the firm could not call the bond, and vice versa, the features would not be interdependent and the with and without values, plus the **value** of the bond as a straight bond, would sum to total bond **value**. Panel B of Figure 10 depicts incremental component values for the same bond, i.e., with the **value** of the straight bond separately identified.

Table 1 presents the bond component values from Figure 10, Panel B, to illustrate four methods to account for the total **value** of $60.00 for the callable, convertible bond. In each case the $57.50 straight bond **value** is stated separately and component values are added incrementally. The first method adds the sum of the with and without conversion and call feature values to the joint **value** of the conversion and call features. The second method adds the pure conversion and call values and subtracts the joint **value** of the call and conversion features. The third adds the with and without **value** of the conversion feature and the pure call feature. The final method adds the with and without **value** of the call feature and the pure conversion feature. Note that either of the first two cases provides information sufficient to construct the other three cases. However, neither the third nor fourth case provides sufficient information to construct the other three. The key piece of missing information in the third and fourth cases is the joint **value** of the components. Any allocation to components of this joint **value** is arbitrary and potentially obscures information. Thus, the most informative implementation of a disclosure standard by the FASB relating to **financial** instrument components would include the joint **value** of the components.

FIGURE 10

Bonds can possess additional features beyond call and conversion features, e.g., put options and sinking fund provisions, which give the firm or bondholders additional decision rights. Figure 11 depicts interdependencies for three component values.14 For bonds with three or more components, the analogous cases to the first two in Table 1 are (1) presenting all with and without values and the joint **value** of all component interactions, i.e., the difference between the bond's total **value** and the sum of the with and without component values; (2) presenting all pure component values and subtracting the joint **value** of the components, which is the difference between the total bond **value** and the sum of the pure component values.
TABLE 1

IMPLEMENTATION ISSUES

Implementing an option pricing-based approach to debt **valuation** presents problems that are not evident in the extended example or in the option pricing-based debt **valuation** literature. This section discusses these problems and how Barth et al. (1998) deal with them.

Dividends

A company may have announced an upcoming quarterly dividend payment, or its recent dividend payment history makes it relatively easy to project dividends for the next few quarters. However, projecting dividends for longer periods is not as straightforward. One alternative is to use the recent history of dividend payments and the current stock price to compute current dividend yield and assume this yield will persist. Unfortunately, this approach requires that the **value** of equity and the dividend be jointly determined in each binomial state. For example, if the dividend

is 1 percent of equity **value** in each binomial state, the dividend cannot be determined until the equity **value** is known, and the equity **value** cannot be computed without knowing the amount of the dividend. Barth et al. (1998) use the recent history of dividend payments to preferred and common shareholders to project dividends as a constant percentage of total capital **value**, rather than as a constant percentage of equity **value**. This not only avoids the problem of simultaneously determining equity values and dividends, but also maintains a recombining binomial tree.

Determining u and d

Barth et al. (1998) compute up and down factors using the method developed in Rendleman and Bartter (1979) that causes binomial option values to converge most rapidly to Black-Scholes values:15

Note that when the values of u and d from equation (5) and the interest factor from equation (6) are used to compute , the risk-adjusted probability associated with the occurrence of the up state, is constant over time, even though the forward rate of interest, R

sub t

, may not be constant.

FIGURE 11

Valuing Multiple Debt Issues

As is evident from the callable, convertible debt example, values of a firm's debt and equity should be jointly determined, because decisions made by one class of security holders affect the **value** of the other security. Analogously, if a firm has more than one debt issue outstanding, the values of all **financial** claims issued by the firm should be jointly determined. In determining the **value** of a particular bond, market participants would not ignore other debt obligations of the issuing firm. For example, if a firm issues more than one convertible bond, the holders of each bond take account of the potential conversion of the other bonds when deciding whether to convert. This suggests the simultaneous **valuation** of multiple debt issues requires the application of complex game theory. However, values for multiple debt issues can be approximated without using game theory. The remainder of this section describes the procedures Barth et al. (1998) use to **value** multiple debt issues for a given firm.

Suppose a firm has four bonds outstanding, denoted as A, B, C, and D. When valuing bond A, we treat bonds B, C, and D as a single straight bond with promised payments equal to the sum of promised payments for B, C, and D. Then, we **value** bond A taking into account the presence of the second bond represented by the collective obligations of B, C, and D. If bond A is a senior claim, then we **value** A as if its payments have priority over the second bond. If A is a general obligation bond, or if no priority can be identified, then we **value** A and the second bond as if it has equal priority in default. If A is a junior claim, then we **value** A as if its payments can be made only if the collective obligations of B, C, and D are met first. If A is a convertible bond, and any of bonds B, C, and D are also convertible, then we assume that any decision to convert A into equity is made assuming the other bonds also have been converted. Otherwise, we ignore any special features of bonds B, C, and D when valuing bond A. After valuing A, we repeat the **analysis** for bond B, valuing B in the presence of a second straight bond whose promised payments equal the sum of promised payments to the holders of bonds A, C, and D. Finally, we repeat this procedure for

bonds C and D.

This **valuation** procedure does not capture all simultaneous **valuation** interactions among the bonds issued by a firm. Nonetheless, the method for selecting binomial **valuation** parameters for volatility, a, and total capital **value**, Ao,0, described in the next subsection helps to minimize this type of **valuation** error.

Selecting Values for sigma and A

sub 0,0

The **valuation** procedure in Barth et al. (1998) determines values for cr and Ao that minimize the sum of squared differences between model values of a firm's debt and equity and their associated market values.16 If a particular bond is not traded and, therefore, its market **value** cannot be observed, the bond's market **value** is not used in the iterative search process. Although, by construction, this procedure minimizes the error associated with no-arbitrage pricing violations, Barth et al. (1998) report that the volatility of equity implied by this procedure is high relative to **historical** equity volatility and that implied by the prices of exchange-traded options.

EXAMPLE: BOISE CASCADE

We illustrate the application of our pricing procedure for valuing debt using Boise Cascade's debt. Unlike the examples presented above, Boise Cascade has multiple debt issues. This facilitates a more complete explanation of how the **valuation** procedure handles multiple debt issues. We **value** Boise Cascade's debt as of December 31, 1990 using data from Barth et al. (1998). Table 2 summarizes the terms of Boise Cascade's debt and equity issues. Although our data include terms not summarized in Table 2, such as call schedules for callable bonds, the information in Table 2 permits illustration of the most salient features of the **valuation** methodology.

Boise Cascade has 19 debt issues, four of which are not valued by the model. We cannot estimate values for these issues because of insufficient data. This is a limitation we face as researchers; Boise Cascade has access to the data required for estimation of values of all of its debt securities. Although we do not estimate values for these four debt issues, we use information about these issues when estimating values for Boise Cascade's equity and its other 15 debt issues.

In implementing the binomial model, we use numerical search to determine the **value** of total capital, i.e., debt plus preferred and common equity, and its standard deviation that minimizes the sum of the squared differences between the market and model values of the debt issues for which we have market values, and common equity. 17 The numerical search procedure does not include bonds for which we do not have market values. However, because we otherwise have sufficient information to **value** these bonds, we estimate their values using the total capital and volatility estimates obtained from the search procedure. Boise Cascade has four such bonds. The model's estimate of the **value** of common equity equals the model's estimate of total capital less the sum of (1) the model values of all bonds valued by the procedure, (2) the book values of all bonds for which we have insufficient data to **value** using the procedure, and (3) the book **value** of preferred stock.

Each binomial period is six months; we assume all interest, principal, and dividend payments are paid at six-month **intervals**. We align debt

issuance dates by assigning the first cash payment for each debt issue to the beginning of the nearest six-month period. We also assume that, over time, the total dividend paid to common and preferred equity holders is a constant percentage of total capital **value**. For example, as shown in Table 2, the total dividend to common and preferred equity holders is $71.51 million in 1990. If, for a given iteration of the search procedure, the initial **value** of total capital were $1 billion, then the dividend rate would be 7.15 percent of total capital, or 3.58 percent every six months. This dividend rate is held constant throughout the binomial tree for this iteration and is recalculated at the beginning of the next iteration depending on the initial level of total capital.

TABLE 2

Table 3 lists the model values for Boise Cascade's debt and equity after the final search iteration. Table 3 indicates that the model's estimates of total capital **value** and its volatility are $3,331.85 million and 35.20 percent, respectively. Table 3 reveals that the **valuation** procedure produces model values that are close to market values for most of the bonds we **value**. Presumably, Boise Cascade's management could obtain even more precise estimates because they have access to more complete information about these bonds.18

Table 4 displays the values of the components of Boise Cascade's convertible subordinated debenture using the format of Table 1. For this bond, the model **value** of $79.15 is close to its market **value** of $79.00. The with and without values of the conversion and call features are $6.97 and $14.86, respectively, and the joint **value** of the conversion and call features is also $14.86. For this bond, the **value** of the call feature is attributable entirely to the ability of Boise Cascade to force conversion of the debt to equity, and not from the ability of Boise Cascade to refinance its debt when its credit quality improves.

CONCLUDING REMARKS

This paper describes an implementation of the binomial option pricing model that can be used to estimate values of corporate debt and its various features including conversion, call, put, and sinking find provisions, and applies the methodology to the **valuation** of debt and equity issues of Boise Cascade Corporation. The paper also illustrates the **valuation** effects of interdependency among debt features. Component **value** interdependencies arise from the components themselves, not from any particular method of valuing them. Thus, any approach to account separately for debt components must consider their **value** interdependence. The paper also explains that the most informative implementation by the FASB of a disclosure standard relating to **financial** instrument components would include joint component values.

TABLE 3

TABLE 4

We thank two anonymous reviewers for helpful comments and suggestions. We gratefully acknowledge funding provided by the **Financial** Research Initiative, Graduate School of Business, Stanford University, and the Center for **Financial** Accounting Research, Kenan-Flagler Business School, The University of North Carolina at Chapel Hill. Professor Barth also received funding assistance from the GSB Faculty Trust Fellowship. Professors Landsman and Rendleman received funding assistance from the Dalton L. McMichael, Sr. Professorship, and Professor Rendleman

also received funding from the John W. Burress III, and the M. W. "Dyke" Peebles, Jr., Fellowships.

1 Since Cox et al. (1979) and Rendleman and Bartter (1979), there have been numerous extensions to the basic framework of the original binomial model. Several of these extensions involve model modification to deal with the empirical observation that the volatility of underlying stock returns implied in the prices of options issued on the same underlying stock are not always the same, as the binomial and Black-Scholes models would suggest; they often depend on the option's strike price and maturity. This indicates that options are sometimes priced as if the volatility of returns for the underlying stock is not expected to be constant over time and is expected to depend on the future stock price. This empirical irregularity and its associated implications for the pricing of options are addressed in Rubinstein (1994), among others.

The binomial model is not the only numerical method for calculating option values. For example, the finite-difference method can be preferable to the binomial model when calculating option prices on an asset from which cash distributions of a fixed dollar amount are extracted. The trinomial model, similar to the binomial model but using three return outcomes rather than two, also can be used to calculate option prices efficiently. Although a Monte Carlo method can be used for valuing complex options or option-like securities, its application to the **valuation** of securities with the potential for early exercise can cause the premium associated with early exercise to be substantially overestimated. Broadie and Glasserman (1994) develops a method for dealing with early exercise in Monte Carlo-based **valuation** of American put options, and its methodology potentially could mitigate the problems associated with early exercise in more complex Monte Carlo-based **valuation**. Hull (2000, 401-428) describes in detail each of these alternative numerical procedures.

2 Pricing using the binomial model has also been shown to be consistent with the risk-return theory of the Capital Asset Pricing Model (CAPM). See Cox and Rubinstein (1985) and Rendleman (1999).

3 If a cash payment is made from the underlying asset at the end of the binomial period, u and d are the returns per dollar invested including both the capital gains and cash components of the returns.

4 Below we show how to choose a and d consistent with an expected mean and standard deviation of the logarithmic, or continuously compounded, rate of return of the underlying asset. As the number of binomial time **intervals**, n, approaches infinity, the resulting distribution of asset values approaches a lognormal distribution. Given the close correspondence between the binomial and normal distributions, this convergence is rapid. Although not developed here, the binomial model can accommodate expected changes in volatility over time, such as that documented in Malkiel and Xu (1999).

Starting with Black and Scholes (1973), the literature and practice of option pricing commonly assumes that the firm's total capital **value**, i.e., debt plus equity, has a lognormal distribution. Early statistical tests of stock returns, such as those summarized in Fama (1970), provide the basis for this assumption. Akgiray (1989) and others show that daily, weekly, and even monthly stock returns can exhibit positive kurtosis and, therefore, their distribution can deviate somewhat from lognormality. Dittmar (1999) provides evidence that monthly stock returns reflect the pricing of kurtosis. However, when valuing corporate bonds, the time horizon for computing returns on total capital can be many years and, therefore, deviations from lognormality in short-horizon returns

is not a major concern.

Technically, we assume the firm's total capital **value** follows a lognormal distribution (or the binomial equivalent). Option pricing theory demonstrates that if a firm is highly levered, its equity **value** is not lognormally distributed. Although the option pricing literature acknowledges this potential inconsistency, it is rarely, if ever, factored into models of stock option and debt pricing. Nonetheless, with moderate amounts of leverage, assuming lognormally distributed total capital values should not result in calculated equity values that deviate substantially from lognormality.

5 The example beginning in Figure 1 is based on a sample firm in Barth et al. (1998).

6 Longstaff and Schwartz (1995) and Jarrow and Turnbull (1995) also employ option pricing theory to model values of specific option-like features of corporate debt, such as conversion and call features, but model default and default-related risk premiums in a non-option pricing framework. In these models, bankruptcy occurs when the firm's total capital **value** reaches an exogenously determined boundary condition, at which time the models assume the firm pays to bondholders a fixed fraction of its total capital **value**. By modeling default outside an option pricing framework, the models can incorporate in bond **valuation** the effects of potential **random** changes in interest rates, an aspect of pricing not captured by the standard binomial model.

7 For simple call and put options, P,,j exceeds the hold **value** whenever it is optimal to exercise the option rather than hold the option for an additional binomial period. For bonds, however, the relative values of Pt., and Hr,j depend on which option is exercised. For example, the firm will call the bond prior to maturity when the call price is less than the hold **value**, in which case P,. is less than H,,,.

8 Rendleman (1999) shows that under CAPM-based pricing, n = 0 - pX 40(1 - 0), where 0 is the true probability associated with an increase in the **value** of the underlying asset, p is the correlation between the return of the stock and the return of the market **portfolio**, and X is the market price of risk.

9 Pricing an option as a risk-neutral or risk-adjusted expected **value** discounted at the risk-free rate is not specific to the binomial model, but also applies to all no arbitrage-based approaches to option **valuation**. This was first recognized in Smith (1976).
10 We do not distinguish between the amount of the cash payment and the reduction in the asset's **value**.

11 When implementing a binomial model for determining bond values, various iterative search techniques are employed to find the values of u and d that best satisfy a specified stopping criterion. Equality of market and model values of equity and equity volatility is a commonly used criterion. This criterion does not require bond market values. Another criterion that uses bond market values, when available, is minimizing the sum of squared differences between market and model values of debt and equity, using those debt issues of the firm for which market values are available, provided there is at least one. This is criterion is illustrated below in the context of the Boise Cascade example. See Barth et al. (1998, 77-79 and 94) for further details.

12 The pricing of zero-coupon debt in the previous subsection can be expressed using the pricing expression P

sub t,j

=min(H

subt,j
+I

sub t,j

,A

subt,j

), where K

sub0

=0, K

sub1

=0,K

sub2

=60,I

sub1
=I

sub 2

,=0,and H

subt,j

=0

13 Nonpayment of interest upon conversion is typical for most convertible bonds.

14 Technically, a callable, convertible bond comprises three components. In addition to the conversion and call features, there is a default feature, which is the firm's option to default on the bond. In our example relating to the callable, convertible bond, the **value** of default is the same regardless of the bond's other features. However, if the call and conversion features affect the risk of default, accounting for the bond's components should include the **valuation** of all three components and their interactions.

15 Although the Rendleman-Banter formulas do not take account of non-constant forward rates of interest, a straightforward extension of their formulas produces equation (5).

16 The procedure minimizes the sum of squared differences between the model and market values per $100 of par **value** of the bond rather than total bond **value**. The difference between model and market values of common equity is 100- model X 100/market. This method standardizes debt and equity so that each bond issue and equity have approximately the same weight in the search procedure, regardless their total dollar values. 17 We employ the amoeba search procedure, also known as the downhill simplex method in multiple dimensions, as described in Press et al. (1992).

18 We estimate values for some bonds using plausible assumptions in the absence of precise data available to management. For example, for a callable bond for which year-by-year call schedules are not reported but beginning and ending prices are, we assume call prices are a linear function of time.

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Geographic Names: United States; US

Descriptors: Bonds; Models; Studies; Valuation; Corporate debt; Pricing policies; Accounting procedures
Classification Codes: 9190 (CN=United States); 9130 (CN=Experimental/Theoretical); 3400 (CN=Investment analysis & personal finance); 4120 (CN=Accounting policies & procedures)
Print Media ID: 14312

30/9/8 (Item 8 from file: 148)
13399045 Supplier Number: 71361339 (THIS IS THE FULL TEXT)
To Your Heart's Content: A Model of Affective Diversity in Top Management Teams.(Statistical Data Included)

Barsade, Sigal G.; Ward, Andrew J.; F. Turner, Jean D.; Sonnenfeld, Jeffrey A.
Administrative Science Quarterly , 45 , 4 , 802
Dec , 2000
Document Type: Statistical Data Included
ISSN: 0001-8392
Language: English
Record Type: Fulltext
Word Count: 18685 Line Count: 01808

Text:

In this study we develop a model of how diversity in positive affect (PA) among group members influences individual attitudes, group processes, and group performance. We test the model on a sample of 62 U.S. top management teams. Greater affective fit between a team member and his or her group is related to more positive attitudes about group relations and perceptions of greater influence within the group. Results also suggest there is a negative relationship between a team's diversity in trait positive affect and both the chief executive officers' use of participatory decision making and **financial** performance. Exploratory analyses reveal that affectively diverse, low mean trait PA groups experienced the greatest task and emotional conflict and the least cooperation. Analyses of diversity in trait negative affect produced no significant results. We discuss the implications of our study for the group emotion, team composition, group performance, and top management team literatures. (*)

The study of the costs and benefits of diversity in the workplace has been going on at a vigorous pace over the last two decades or more. This research has led to many theoretical and practical insights into the effects of diversity on organizational life (Jackson, 1991; Milliken and Martins, 1996). Rich as this research has been, its focus has been mainly on constantly observable forms of difference, primarily race and gender, with explanations for the crux of the difference based on cognitive factors such as perceived differences in attitudes or values. While these demographic and cognitive differences are certainly important, another type of diversity, based on potentially powerful psychological personality factors, also influences organizational functioning. This is trait positive affective diversity, or individual differences in positive affective personality--the degree to which a person is cheerful and energetic (high positive affect) versus subdued and reserved (low positive affect).

Employee affect has become an area of increasing focus in its own right in organization studies (for a review, see Isen and Baron, 1991; Weiss and Cropanzano, 1996). This interest has included a joint inquiry into employee affect and group dynamics (e.g., Smith and Crandell, 1984), a pairing that has been implicit in studies of group morale as "group spirit" (Muchinsky, 1983: 304), organizational climate defined as group affective tone (see Schneider and Reichers, 1983, for a review), and in the emphasis on the affective bonds between group members in the literature on groups and cohesiveness (Ashforth and Humphrey, 1995). **Historically**, what has been missing from much of this research is a systematic examination of how affect, clearly defined and carefully operationalized, influences individual and group processes and outcomes. Studies that have carefully measured and defined affect have now begun to demonstrate more explicitly the influence of group affect on individual and group-level behavior. Looking at t he mean level of group affect, George (1990, 1995) found that positive affective work-group tone was associated with decreased absenteeism and better customer service. The emphasis on mean level of affect in the field is particularly relevant when groups are homogenous. As with other group composition variables, however, groups can vary widely in their affective distribution, and thus, groups' diversity in positive affect can help us explain and understand other sources of work teams' feelings, attitudes, and behaviors. To date, a team's composition has been primarily studied through demographic variables such as age, gender, and race, or through organization-related characteristics such as tenure or functional background. These characteristics are used as operationalizations, or proxies, for deeper, generally cognitive or **value**-based differences between individuals, but they are based on cognitive, not affective, similarity-attraction arguments. Our study

adds an affective and personality-based focus to this line of research, which has the potential to shed new light on the influence of team composition on group life by focusing on a group's diversity in positive affect.

POSITIVE AFFECTIVE DIVERSITY IN GROUPS

In considering affective diversity and its consequences, it is important to be clear about what type of affect is being studied. We focus here on a person's trait of positive affect (PA), which is his or her stable underlying affective personality (Staw, Bell, and Clausen, 1986; Watson, Clark, and Tellegen, 1988) and leads to relative consistency in affective reactions over time (Lazarus, 1991; Watson and Walker, 1996). Trait affect does not need a specific target; it is a generalized tendency toward having a particular level of positive and negative moods, which then permeate all of an individual's experiences (Lazarus, 1991). Extensive work by psychologists studying affect has focused on the trait of positive affect, the degree to which a person is high in enthusiasm, energy, mental alertness, and determination (Watson and Tellegen, 1985; Watson, Clark, and Tellegen, 1988), and on the trait of negative affect, the degree to which one feels subjective distress, such as irritability, anxiety, or nervousness (Watson and Clark, 1984). In our study, we focus on positive rather than negative trait affect. Although, semantically, positive and negative trait affect sound as if they are two sides of a bipolar scale, they are each in fact unipolar constructs that have been shown to be largely independent over time (e.g., Diener and Emmons, 1985; Goldstein and Strube, 1994), to operate according to different processes (e.g., Heller, 1990; Fredrickson, 1998), and to relate to different types of predictor and outcome variables (e.g., Watson et al., 1992). Researchers who have examined differences between the two constructs have found a significantly stronger link between trait positive affect and the social processes inherent in the group settings we examine. (1)

We chose to model the effects of trait positive affect because it is dispositional and therefore lies directly within the realm of "basic attributes" that Pfeffer (1983: 303) discussed in his classic description of the compositional effects of groups. Also, trait affect has already been shown to influence many aspects of organizational life, ranging from consistency in job attitudes and satisfaction to work performance (e.g., Staw, Bell, and Clausen, 1986; Brief et al., 1988; Cropanzano, James, and Konovsky, 1993). Although there has not been as much work examining the influence of trait affect on a group level, there is mounting evidence that it can be a useful explanatory construct in understanding workplace behavior (e.g., George, 1990, 1995).

Research has shown trait positive and negative affect to be classic personality factors, congruent with extraversion and neuroticism (John, 1990: 86), a result repeatedly demonstrated in the literature (see Parkinson et al., 1996: 61; reviews by Larsen and Diener, 1992; Meyer and Shack, 1989). We chose to focus on trait affect, however, rather than other personality variables, as trait affect is a more narrowly affectively defined construct, which leads to specifically affective manifestations (Tellegen, 1985; Watson and Clark, 1992; Parkinson et al., 1996: 61). This is by contrast, for example, to extroversion, which in addition to affective components such as cold and warm includes many other, less purely affectively related components, such as degree of sociability, talkativeness, spontaneity, and being a joiner versus being a loner (Costa and McCrae, 1992). Trait positive affect appears to be the best candidate for an initial study of how affective diversity relates to the interaction and performance of t op management teams. While there is not as much prior research supporting a negative affective diversity model, we feel it is too soon to rule out negative affect in this context and thus conduct exploratory trait negative affectivity tests for all of our hypotheses as well.

Group Composition

Analyses of the effects of group composition have been used to

explain a wide variety of group phenomena, such as turnover, interpersonal relations, innovation, and performance, in general work groups (for reviews, see Jackson, 1995; Williams and O'Reilly, 1999) and in top management teams (see Finkelstein and Hambrick, 1996). Here, we focus on the group's diversity in trait positive affect. As with other group composition variables, when a group is interacting, members should react to each other's trait positive affect. Although trait positive affect is not a demographic characteristic, it is still readily identifiable, perhaps more so than the underlying values demographic characteristics are meant to represent. Research by Ekman and colleagues (1982) has shown that internal emotional states are reliably observable and can "leak" even when people are trying to hide them (Ekman, 1992). Supporting this, strong correlations have been found between peers' ratings of trait positive affect and self-report ratings of trait positive affect, as well as among the peer raters themselves (Barsade, 1995), indicating the observability and reliability of trait positive affect.

Trait emotion can also influence group functioning through its effect on mood, or state affect. State and trait affect are so closely related that they have been described as the "former being provoked in a specific context, the latter (background) influencing this provocation" (Lazarus, 1991: 47). While state affect is a shorter-term reaction with greater fluctuation than trait affect (Tellegen, 1985), researchers have viewed their underlying processes as being very similar (see Allen and Potkay, 1981; Ekman and Davidson, 1994: 49-96), with trait affect at the personality level strongly helping to determine state affect (Lazarus, 1991: 47). Thus, a combination of individuals' mood states will reflect their overall trait affect, and other individuals with whom a given individual interacts regularly will perceive and characterize the person by his or her underlying trait affect moderated by short-term mood states. Because trait affect can be perceived, it is likely to be the basis for similarity-attraction eff ects similar to the cognitive similarity-attraction effects discussed by researchers studying diversity with demographics and underlying cognitive or **value**-related variables.

Affective Similarity-Attraction

Affective diversity is a result of the cumulative affective fit or misfit among group members. This fit is important because, as with other **value** or demographic differences, people care about how similar they are to others on a variety of dimensions. The finding that people consciously and unconsciously prefer others who are similar to them is one of the most robust and reliable social psychological findings (see Berscheid, 1985, for a review). This phenomenon has also been strongly supported in the small group and organizational context (see Williams and O'Reilly, 1999, for a review), and in sociological research on homophily, defined as "the tendency for persons who affiliate with each other to be similar on various attributes" (Hogue and Steinberg, 1995: 897). The general finding in these literatures is that people prefer to interact with other individuals or groups who have (or are perceived to have) attitudes and values similar to their own (e.g., Byrne, 1971; Berscheid, 1985; Schneider, 1987; McPherson and Smith-Lovin, 1987). While the research in similarity-attraction has not traditionally sought a source of affective similarity and difference, there is evidence that these processes operate similarly and that emotions can be a fruitful area in which to examine similarity-attraction effects (Berscheid, 1985: 424).

A theoretical base for the similarity-attraction effect is the concept of reinforcement and the reinforcing **value** of similar attitudes or values (see McGuire, 1985, for a review). While reinforcement effects have classically been studied with regard to cognition, much of the logic behind this research in attraction (e.g., Newcomb, 1961; Byrne, 1971; Lott and Lott, 1985) can be applied to emotions as well. Although they studied cognition, not affect, Clore and Byrne's (1974) description of the similarity-attraction process helps our understanding of how reciprocal

reinforcement could also occur affectively. Clore and Byrne's cognitive argument can be summarized as follows: "I think the same way you do, which I find reinforcing, which makes me feel good, which then makes me attracted to you, which is then reciprocated by you." As affect can be a type of reinforcer in its own right (Lott and Lott, 1974), their argument could be modified to describe similarity-attraction in terms of positive affect. Imagine a sit uation in which an employee who has high trait positive affect (cheerful and energetic) meets another employee who is also this way. The reciprocal emotional information would be conveyed as follows: "I feel the same way you do (i.e., upbeat and energetic), which I find reinforcing, which makes me feel good, which then makes me attracted to you, which is then reciprocated by you." In this way, positive affect can serve as information, affective similarity confirms the appropriateness of emotions, and this reinforcement then leads to attraction. The reinforcing properties should occur for people at all levels of positive affect. Thus, one can also imagine a situation in which a subdued and reserved (low positive affect) employee interacts with the cheerful and energetic (high positive affect) employee described above: "I do not feel the same way you do, so I do not feel your emotional response is reinforcing, which makes me feel bad, which does not lead me to be attracted to you, and this lack of attraction is then reciprocated by you."

Another rationale for the cognitive similarity-attraction effect is Davis's (1981) consensual validation model. He stated that attitudinal similarity is reinforcing in its own right because it gives desired consonance and constancy and serves as confirmation that one's view of the world is correct. Psychological research in perception, memory and learning, and self-verification would support a view that people have a desire for affective consonance that is similar to their desire for cognitive consonance or their dislike for cognitive dissonance (Festinger, 1957). For example, the findings of self-verification research (e.g., Swann et al., 1990; Swann, Stein-Serroussi, and Giesler, 1992) demonstrate the importance of consonance, that having one's own feelings validated can be more important than a positive evaluation when the other's evaluation is in conflict with one's own evaluation. Also, affective congruence is posited to offer a necessary conceptual coherence (Niedenthal and Halberstadt, 1995), similar t o the coherence gained from the cognitive consistency discussed by Newcomb (1961).

There is also direct evidence for affective-similarity attraction effects, particularly in studies of the similarity-attraction effects of being in a very low positive affect state, or depressed mood (e.g., Rosenblatt and Greenberg, 1991). Locke and Horowitz (1990) showed that similarity in dysphoria (similar to low positive affect), irrespective of actual dysphoria, is the critical determinant of satisfaction with a dyadic interaction and that this satisfaction increases as the length of the interaction increases. Lastly, Davis (1981) also proposed a "rewards of interaction model," which states that **value**/cognitive similarity is attractive because it leads to future expectations of rewarding interpersonal interaction (e.g., behavior, activities, and communication). The same processes and rewards should occur with affective similarity: "If I enjoy being with you affectively, I will be more likely to give you other rewards, including interacting with you more."

Individual-level Attitudes and Self Perception

Satisfaction. Affective diversity should influence individual levels of satisfaction with the group. The more similar a group member is to others in the group in positive affective personality, the more satisfied that group member should be with the group's interpersonal relations (e.g., Locke and Horowitz, 1990). Researchers have found demographic similarity to be associated with greater satisfaction and commitment (Meglino, Ravlin, and Adkins, 1989; Verkuyten, de Jong, and Masson, 1993), more trusting relationships between negotiation partners (Valley, Mannix, and Neale, 1995), more supportive relationships (Ibarra, 1992), and greater empathy toward similar people in need and thus putting higher **value** on

their welfare (Batson et al., 1995). As homogeneity has been shown to lead to greater personal attraction and satisfaction with relationships, and similarity within work teams has been shown to lead to more positive feelings about people in the group, we hypothesize the following:

Hypothesis 1: Individual group members who are more similar to others in their group in trait positive affect will be more satisfied with the interpersonal nature of their group experience than those who are more affectively dissimilar.

Perceptions of individual influence. Another expected outcome of being affectively similar to others is a high self-perception of one's influence level in the group. While the social psychology literature has long established the presence of individuals' tendency to assume that others will perceive the world as they do, even when there is evidence to the contrary (Ross, 1977; Ross, Green, and House, 1977), this effect of projecting our own opinions and attitudes onto others has been shown to be even greater when we like others or believe that they are similar to us (Vroom, 1959). Research has also shown that similarity, or perceived similarity, also leads people to be more willing to be influenced by similar others (e.g., Cialdini, 1993). For example, Enz (1988) found that perceived **value** congruity between senior managers and department members led to greater departmental power, as perceived by both the department members and the senior management. Thus, we hypothesize:

Hypothesis 2: Individual group members who are more similar to others in their group in trait positive affect will perceive themselves as having greater influence within the group than those who are more affectively dissimilar.

Group Level Social Processes

Cooperation and conflict. Following from the argument for satisfaction on the individual level, affectively homogeneous groups should be more cooperative and have less conflict than affectively heterogeneous groups because of the greater feelings of familiarity, attraction, and trust that are engendered from affective similarity-attraction processes. These reinforcing effects of similarity in affect will then be associated with more cooperative and cohesive group processes. There is ample support in the diversity literature for this process occurring. A team's demographic heterogeneity, on a variety of factors, has been found to be related negatively to team rapport (O'Reilly, Snyder, and Boothe, 1993) and informal communication among team members (Smith et al., 1994). Similarly, a group's demographic heterogeneity has been found to impede teamwork and to lead to difficult information exchange (Ancona and Caldwell, 1992).

With regard to intragroup conflict, there is evidence that differences in demography (Alagna, Reddy, and Collins, 1982; Pelled, 1996b; O'Reilly, Williams, and Barsade, 1998) and personality (Haythorn et al., 1956) lead to increased conflict. The construct of conflict has often been divided into two areas, relationship conflict, pertaining to interpersonal incompatibility among team members, and task conflict, pertaining to disagreement about how the group tasks should be performed (Pinkley, 1990; Jehn, 1995). Jehn and her colleagues have found relationships between demographic variables and both types of conflict (e.g., Jehn, Northcraft, and Neale, 1996; Jehn, Chadwick, and Thatcher, 1997). We therefore propose:

Hypothesis 3: Affectively homogeneous groups will have greater cooperation and less task and relationship conflict than will affectively diverse teams.

Participative leadership style. Leaders are expected to be participative in leading their groups when they perceive them as being affectively similar to themselves. Pfeffer (1983) discussed how perceived homogeneity in demographic characteristics, particularly length of time employed in the organization, can lead to less reliance on formal, bureaucratic controls in organizations than on informal, more **value**-based control (e.g., Ouchi, 1981). The rationale is that the attraction, comfort, and reinforcement that comes from feeling similar will assure members that the appropriate group behaviors will be followed

without the need for formal rules or controls. A psychological parallel to this can be found in a study by Gruenfeld et al. (1996), who found that groups of people who are comfortable and familiar with each other perform better than groups of strangers in a problem-solving task in which information sharing is necessary, a situation similar to that of top management teams. Westphal and Zajac (1995) found that the less demographic distance between the CEO and the board, the less the tendency for directors to challenge managerial preferences in the name of shareholder interests. A similar rationale can be applied to chief executive officers (CEOs) ceding more power to their teams. As Smith et al. (1994: 415) discussed in their study of top management team demography and social process, diverse teams may be viewed as less predictable in their attitudes and behaviors than homogeneous teams, and thus predictability and control will likely be enforced by the CEO through monitoring (Holmstrom, 1979) and rules and regulations (Eisenhardt, 1989). We reason that leaders who feel similar to their teams trust their teams' perspectives to be similar to their own and will be more likely to give their teams greater decision-making power:

Hypothesis 4: Similarity in trait positive affect between a group leader and his or her group members will lead to the leader's using a more participative than autocratic decision-making style.

Group Performance

There are competing theoretical arguments and empirical results relating to the effect of diversity on performance, and an extensive literature on the antecedents of group performance has arisen. Many researchers have found that there are negative effects of diversity, as heterogeneity creates distance between group members, which makes trust, rapport, social integration, and communication less likely (O'Reilly, Caldwell, and Barnett, 1989; Zenger and Lawrence, 1989; Tsui, Egan, and Xin, 1995), leading to implementation problems (Simons, 1995) as well as turnover (Jackson et al., 1991). Other researchers have argued--based on the theoretical argument laid out by Hoffman and Maier (1961)--that group heterogeneity enhances the breadth of perspective, viewpoints, cognitive resources, experiences, and general problem-solving ability of the group and that diversity can therefore help enhance performance (e.g., Cox, Lobel, and McCleod, 1991). As there is currently no clear consensus about how heterogeneity influenc es performance outcomes (Guzzo and Dickson, 1996), and as different dimensions of diversity have different impacts, we discuss each perspective below and posit competing hypotheses on the influence of trait positive affective diversity on group performance.

Affective homogeneity. There is substantial evidence that demographic homogeneity can positively influence group performance (see Williams and O'Reilly, 1999, for a review). As we predicted in hypothesis 3, affective homogeneity should lead to greater cooperation and less conflict. Greater cooperation and less conflict should reduce friction and increase efficiency in task performance, particularly with complex tasks that require information sharing, such as those facing top management teams. In a study of top management teams, Bourgeois (1980) found that disagreement and lack of cooperation were associated with decreased performance. Amason (1996) differentiated between cognitive conflict and affective conflict, and although cognitive conflict had a beneficial impact on decision making, affective conflict had a negative impact. Cognitive conflict concerning the merits of the ideas enhances decision making by allowing the group to refine and reject suboptimal solutions, while affective conflict is often direc ted more at the person than the idea, proving more destructive and isolating and thus reducing group effectiveness. Pelled (1996a) argued that performance may be reduced in groups in which there is affective and substantive conflict due to anxiety, psychological strain, lack of receptivity to ideas, and inability to assess new information-energy is spent on the conflict instead of the task. These process losses may lead to the poorer implementation found in heterogeneous teams (Simons, 1995).

In highly complex tasks, such as those facing a top management team,

though informational diversity should theoretically be more beneficial than in routine tasks, this does not always play out in practice. O'Reilly and Flatt (1989) found that top management teams with homogeneous organizational tenure were more creative than teams with more diverse tenure. Dougherty (1992) found that cross-functional product teams had difficulty getting their products to market, and Ancona and Caldwell (1992) found managers' ratings of innovativeness to be lower when teams were functionally diverse than when they were homogenous. Thus, we predict the following:

Hypothesis 5a: Affectively homogeneous groups will have better group performance than will affectively diverse groups.

Affective heterogeneity. There is also support in the demography and group performance literatures for negative outcomes of group homogeneity and positive outcomes of het erogeneity, or diversity, particularly as it promotes debate or conflict over the task (see Milliken and Martins, 1996, for a review; Watson, Kumar, and Michaelsen, 1993; Jehn, 1995). Amason and Schweiger (1994) proposed that the positive aspect of task conflict is that it allows group members to identify and discuss diverse perspectives, thus increasing the evaluation of the criteria needed to make a high-quality decision. This is particularly true when the task requires creative problem solving and innovation, as the availability and expression of alternative perspectives can lead to novel insights (Nemeth, 1986). Most researchers studying top management teams have found positive relationships between top management team diversity and innovation (Bantel and Jackson, 1989), company growth rates (Eisenhardt and Schoonhoven, 1990), firm perfo rmance (Roure and Keeley, 1990), and effectiveness in responding to competitors (Hambrick, Cho, and Chen, 1996). Also, findings in social psychological research can help explain this with findings showing that group uniformity may be "secured at the expense of group success and group adaptation to the environment" (Moscovici, 1985: 350) and that a desire for uniformity can lead to an inability for group members to criticize and challenge ideas within the group, what Janis (1982) referred to as "group think." Thus, we also posit a competing hypothesis to the one above:

Hypothesis 5b: Affectively diverse groups will have better group performance than will affectively homogeneous groups.

Mean Level of Trait Affect

Though the literature on the relationship between affect and group-level performance variables is quite small, there is a vast body of research examining mean affect and judgment and performance tasks on an individual level, and there may be a parallel between the individual and group processes (Kelly and Barsade, 2001). Almost all research examining group-composition effects related to affect has concentrated on the relationship between the mean level of affect and various group processes and outcomes (e.g., George, 1990, 1995). As a result of this literature, two different perspectives regarding how positive emotional influence relates to individual attitudes, interpersonal processes, performance, and judgment have emerged. The first literature stream, as exemplified by research conducted by Isen and colleagues, has shown a beneficial direct effect of positive affect on judgment. For example, inducing positive mood leads to greater creativity, more efficient cognitive processing, and better use of heuristic s in complex decision-making tasks, as well as broadened categories for information sorting and greater flexibility in categorization (see Isen, 1999, for a review). Inducing low positive affect (i.e., depressed mood) has also been shown to have a negative effect on cognitive performance (Mitchell and Madigan, 1984; Zarantonello et al., 1984). In contrast, the "depressive realism" literature (e.g., Alloy and Abramson, 1979, 1982; see also Golin, Terrell, and Johnson, 1977; Tabachnik, Crocker, and Alloy, 1983) offers the opposite prediction, which is that lower positive affect will lead to beneficial results in organizationally relevant contexts, as those who are more depressed will be more realistic and less likely to make mistakes in judgment based on self-enhancement biases. Staw and Barsade (1993) directly tested these two

competing hypotheses, using trait positive affect as their predictor variable. Examining the relationship between trait positive affect and performance in a series of managerial simulati ons, they found that better decision making, social interaction, and leadership ratings were found in subjects high in trait positive affect than in those low in trait positive affect, giving support to the view that higher trait positive affect will lead to better individual attitudes, group processes, and performance outcomes. Thus, while it is not the focus of our study, we expect to find a positive relationship between the mean level of a team's trait positive affect and individual attitudes, group processes, and performance.

We have hypothesized that the affective diversity effects discussed above will hold true regardless of whether the group is pleasant or unpleasant, yet given the inherently negative valence of unpleasant emotion, it is natural to question whether mutual unpleasant emotion can also be positively reinforcing. There is evidence on both sides of this case. Even for unpleasant affect, research has shown that people with a negative self-perception prefer for others to see them as they see themselves--their desire for self-confirmation overcomes their desire for positive evaluation (e.g., Swann et al., 1990; Swann, Stein-Serroussi, and Giesler, 1992). There is also a large body of research showing that depressed people (e.g., Byrne, 1971; Rosenblatt and Greenberg, 1991) or those about to undergo an unpleasant experience (e.g., Schachter, 1959) prefer to engage with people perceived as being in a similar situation (e.g., Miller and Zimbardo, 1966; Gibbons, 1986; Hogue and Steinberg, 1995).

While the preponderance of evidence seems to support a completely homogeneous attraction-similarity effect, regardless of the mean level of affect, there is some evidence that would support an interaction effect between affective diversity and the mean level of affect, such that homogeneity in low-positive-affect groups could lead to different group outcomes than homogeneity within high-positive groups. There is support from motivated cognitive processing theory (Clark and Isen, 1982; Forgas, 1991) for the benefit of injecting pleasantness into a group (Isen, 1985; Saavedra and Earley, 1991). Studies show that, on average, people avoid situations that would reduce their positive emotions (Isen and Simmonds, 1978; Isen, Nygren, and Ashby, 1988) and that they seek out and remember pleasant experiences more than unpleasant experiences (Singer and Salovey, 1988). Thus there is sufficient cause to test for interaction effects beyond our main homogeneity effects. Because this is an exploratory **analysis**gt;, however, an d these interactional effects could take a variety of forms, we do not posit a formal hypothesis here but, rather, conduct a conservative test for the interaction.

The model developed through the theory above is shown in figure 1. We use this model to examine the influence of an individual's trait positive affective fit with his or her work group and then explore the contributions of positive affective diversity (that is, affective homogeneity and heterogeneity), mean level trait positive affect, and the interaction of these two variables on individual attitudes and group processes and performance through an examination of trait positive affective diversity in the context of ongoing top management teams.

METHOD

Sample

The sample consisted of the CEOs of 62 u.s. companies and 239 of their top managers. The sample was derived from the participants at two CEO conferences held at an East Coast university. Invitees to both conferences were executives of leading organizations in their fields. The first conference invitation list consisted of CEOs from the Fortune 500 industrials; the largest 100 privately held companies in the U.S.; leading service companies (e.g., the top 25 advertising agencies and law firms, the top 10 consulting firms, the Big 6 accounting firms, etc.); leading not-for-profit organizations (including government agencies, educational institutions, professional associations, health research organizations,

philanthropic organizations, and environmental organizations), and a small number of newsworthy emerging-growth companies. Invitees to the second CEO conference were CEOs from the largest 250 companies listed on the NASDAQ Stock Exchange (size defined as market capitalization).

Because of the nature of the conferences, we were in the unusual position of being able to obtain self-report trait affect, demographic, attitudinal, and group dynamic data from the CEOs and their senior management teams. The procedure for this was as follows: CEOs who registered for the CEO conferences were sent the questionnaire to complete before arriving at the conference. The questionnaire included trait affect items and demographic questions (as well as other items not related to this study). The questionnaire was an integral part of the general group feedback CEOs were to receive about themselves and their CEO peers at the conference, and CEOs were also told that they would be given individualized personality reports about themselves and their senior management team. We believe this assisted in obtaining the high CEO response rate of 67 percent. As part of the questionnaire, we asked CEOs to list the names of their top management team members and requested permission to send these managers a questionna ire as well. Having the CEO list his or her top management team members allowed us to access directly (rather than infer from job titles) the people whom the CEO considered to be members of the top management team. CEOs listed an average of 4.41 top managers (s.d. = 3.07), and we mailed a questionnaire to each of these. The top management team's response rate for the questionnaire was also high, at 70 percent. The top management team questionnaire consisted of individual trait affect items, individual satisfaction and perceived influence measures, demographic information, questions about team-level conflict and cooperation, and an assessment of the degree of participativeness versus autocratic decision-making style of the CEO (as well as other questions not related to this study). To be included in the final sample, the CEO and at least two top managers had to complete the survey. This excluded 39 organizations, leaving 62 organizations in the final sample.

The final sample of 62 organizations varied across industry and covered the profit (both private and publicly held) and not-for-profit sectors. The publicly held companies performed slightly above the market average, with a mean market-adjusted return in 1995 of .038 (s.d. = .209). Many were newer companies, with half founded after 1971. The sample also included some older companies, which brought the mean company age to 40.46 years (s.d. = 38.24).

Positive Affective Team Composition Variables

Individual trait positive affect (PA). Trait PA is people's tendency toward pleasant emotional engagement with, or appraisal of, their environment (Staw, Bell, and Clausen, 1986). High PA is characterized by high levels of enthusiasm, energy, mental alertness, and determination, while low PA is characterized by down-heartedness, dullness, and sluggishness (Watson and Tellegen, 1985). We measured trait PA with the highly reliable and valid Well-Being Scale from the Multidimensional Personality Questionnaire (MPQ), formerly called the Differential Personality Questionnaire (Tellegen, 1982). For use here, the scale was converted from a true-or-false format to a 7-point Likert-type scale. Sample items are "I always seem to have something pleasant to look forward to," "I often feel happy and satisfied for no particular reason," and "Most days I have moments of real fun and joy." The mean of the 11-item PA scale was 5.48 (s.d. = .80), and the Cronbach alpha reliability was .87. To ensure that we were not missing an affective component of these teams, we also created team compositions variables assessing trait negative affect in the teams which were analogous to the positive affect variables. Descriptions of these variables can be found in Appendix A.

Affective diversity was measured through heterogeneity in trait positive affect at both the individual and team level. To measure diversity at the individual level, we followed Tsui and O'Reilly (1989) by calculating each top management team member's relational demography score,

his or her affective dissimilarity from the rest of the senior management team, using the formula for Euclidean distance:

$$\left(\sum_{i=1}^{n} \left((S_i) - (S_i)/n\right)^2\right)^{1/2}$$

where (S_i) = the respondent's own score on the dimension being examined (e.g., dispositional affect), (S_j) = each of the other top management team members' score on the dimension being examined (e.g., dispositional affect), and n = the number of senior managers on the top management team. This method is commonly used (e.g., O'Reilly, Caldwell, and Barnett, 1989) to examine how different an individual is on a particular dimension from each of his or her fellow group members. The mean trait PA relational demography score for the entire top management team (including the CEO) was 1.01 (s.d. = .45). We also used each CEO's trait PA relational demography score separately as the. predictor variable for affective diversity when examining the CEO's participative decision-making style. The mean trait PA relational demography score for the CEOs was .94 (s.d. = .38).

To measure group-level affective diversity, we used the standard deviation of the top management team's trait PA, instead of the often used coefficient of variation, because our primary predictor variable, trait PA, was measured on an **interval** rather than a ratio scale (Allison, 1978). The standard deviation was also useful in our analyses in testing for the separate effects of the mean and the variance in the same equation and in testing interaction effects. The standard deviation of the top management teams ranged from .18 to 1.58, with a mean standard deviation of .71 (s.d. = .25).

Mean level trait positive affect. Group-level trait positive affect was calculated as the average of the team members' trait PA scores, including the CEO (x = 5.51, s.d. = .37). For individual-level analyses, we calculated a variable to control for the trait PA of the other members of the team. This variable represents the mean trait PA of everyone minus the self (x= 5.52, s.d. = .41).

Perceived group positive culture. To control for perceptual biases in the individual-level analyses, we measured team members' (not including the CEO) perceptions of the positive affective culture in their top management team by having them rate the following three items: "The emotional culture of our top management team is enthusiastic and cheerful," "The emotional culture of our top management team is pleasant as opposed to unpleasant," and "The emotional culture of our top management team is depressed, sluggish and gloomy" (reverse coded). We calculated a perceived team positive culture score for each team member by taking his or her mean rating on the three items (scored on a 7-point Likert scale; 1 = Strongly Disagree through 7 = Strongly Agree). The mean perceived team positive culture was 5.68 (s.d. = 1 .21) and the Cronbach alpha reliability was .81. This perceptual measure differs from the trait PA measures in that it is not a measure of stable personality dispositions but, rather, is meant to indica te team members' general feelings about their team.

Dependent Variables

Individual-level attitudes and self-perceptions. Our measure of satisfaction with team interpersonal relations came from team members answers to the following three questions on how satisfied they were with (1) the way they were treated by other members of the top management team, (2) the way they were treated by the CEO, and (3) the interpersonal relations between top management team members. They rated each item from 1 to 7 (1 = very dissatisfied through 7 = very satisfied), and the mean of this scale was 5.55 (s.d. = 1.16), with a Cronbach alpha of .73. We assessed self-perceptions of influence within the team by asking team members the following two questions: (1) "I feel I have a great deal of influence on the CEO regarding decisions within my area of responsibility," and (2) "I feel I have a great deal of influence on decisions made by the top management team." These items were assessed on a scale of 1 (Strongly Disagree) through 7 (Strongly Agree), with a mean of 5.86 (s.d. = 1.27) and

a Cronbach alpha of .70.

Group-process measures. We asked senior managers (not including the CEO) about the degree of conflict and cooperativeness in their top management team. For each company, we used the mean of the senior managers' perceptions about the group process (e.g., conflict) as the group-level dependent variable. We measured group conflict using Jehn's (1995) conflict scale. Task conflict was measured by three items asking about differences of opinions in the top management team, team disagreement about work being done, and general degree of task conflict in the top management team. The mean of each team's task conflict score was 3.54 (s.d. = .89), with a Cronbach alpha of .73. Emotional conflict was measured through a four-item scale that asked about personality clashes in the top management team, degree of anger, degree of friction, and the general amount of emotional conflict in the top management team. The mean of each team's emotional conflict score was 3.42 (s.d. - 1.11), with a Cronbach alpha of .93.

Group cooperativeness. We combined two scales to make a seven-item group cooperativeness scale. The first scale consisted of the following four items: "There is a great deal of competition between members of our TMT" (reverse coded); "Members of our TMT view themselves as a team"; "When our TMT has done well, I have done well"; and "There is a lot of unpleasantness among people in this TMT" (reverse coded) (Alderfer and Smith, 1982). The second scale consisted of the following three statements: "I benefit when our team as a whole does well"; "Members of this group care a lot about it and work together to make it one of the best"; and "The members of our TMT really stick together" (Wageman, 1995). These items were scored from 1 (Strongly Disagree) to 7 (Strongly Agree), with a mean of 5.26 (s.d. = .63) and a Cronbach alpha of .82.

CEO participative leadership scale. Our CEO participative-leadership-style scale measured each CEO's degree of participativeness versus autocracy as rated by their top management teams. The members of the team completed a 17-item decision-making scale based on a combination of Heller's (1971) and Vroom and Yetton's (1973) leadership style questionnaires (see Appendix B for a detailed description of this scale). Team members were asked about the degree of participativeness of their CEO when dealing with different types of organizational issues, such as strategy, human resources, and **finance**. The higher the rating, the more participative the CEO. The Cronbach alpha for this scale was .90. The ratings were aggregated across each group's top management team members to form a group-level score for each CEO (x = 5.90, s.d. = 1.18 on a 1-10 scale).

Group performance measures. We obtained information on **financial** performance for the public companies in the sample from the COMPUSTAT industrial file and the Center for Research in Security Prices (CRSP). The variable used to measure **financial** performance was the logged annual market-adjusted return, averaged across each year that the entire top management team (including the CEO) worked together. Market-adjusted returns indicate the company's stock returns minus the return on a **value**-weighted market index. Market-adjusted returns are a widely used metric to judge firm performance, as they are not biased by overall market performance (Brown and Warner, 1980). They also enable the most equitable comparison of performance across industries, which was necessary for our sample, which was very industry-diverse. We could not use accounting measures, such as ROA (return on assets) or ROE (return on equity), commonly used in studies focusing on a single industry, as they generally provide poor comparisons across ind ustries, especially between people-intensive service industries and capital-intensive manufacturing industries.

Control Variables

Demographic variables were not the focus of this study, but because organizational demography and team composition research has shown that various aspects of a team's demographic composition can influence group processes and outcomes, including in top management teams (see Hambrick,

1994, for a review), the following demographic information was obtained for each top management team member as control data: sex (0 = male, 1 = female); age; years of company tenure; number of years on the top management team; functional background (coded into the following nine categories: general management, **finance**, operations, marketing, human resources, legal, accounting, entrepreneurial, and other); educational attainment (coded as 0 = high school degree or less, 1 = college, 2 = M.B.A/graduate degree); and the prestige of the undergraduate or graduate universities attended. (2)

Company-level control variables included the age of the company; number of managers on the senior management team (as listed by the CEO); the company's status as public, private, or not-for-profit; and a size index for the public companies (based on market capitalization). Descriptive statistics of these team and individual characteristics can be found in table 1.

We controlled for demographic composition in individual-level analyses by including each senior manager's demographic characteristics in the equation, as well as his or her Euclidean distance from the team on each characteristic. In group-level analyses, the team means for the demographic variables were included as well as the team's standard deviations. For categorical variables, such as functional background, we used Blau's (1977) index of heterogeneity instead of standard deviations to index group-level differences. The formula for Blau's index (1977) is 1 - (sigma)(pi.sup.2), where p equals the percent of individuals in a category and i equals the number of different categories being measured.

To reflect the findings of previous organizational demography studies, and to conduct a more conservative test of the affective diversity variable, all of the demographic characteristics, individual, group-level, and relational demography measures listed in table 1 were entered on the first step of a hierarchical regression in each of our analyses. Only those variables found to be significant were entered in subsequent analyses and are listed in the correlation matrix in tables 2 and 3.

RESULTS

The means, standard deviations, and intercorrelations among all variables used in the analyses are reported in tables 2 and 3. The hierarchical regression in table 4 (model 1) supports hypothesis 1. Controlling for the demographic and affective control variables, there was a significant effect of affective diversity. The more similar in trait positive affect (PA) a team member was to his or her fellow team members, the greater his or her satisfaction with the interpersonal relations on the top management team. There was no significant effect of mean trait PA and no interaction effects between mean trait PA level and affective diversity. Model 2 shows that, as predicted by hypothesis 2, controlling for demographic and affective controls, there is a significant effect of affective diversity The more affectively similar a team member is to the trait PA of others in his or her team, the greater is his or her perceived influence. No main effects of mean trait PA level or interaction effects between mean trait PA level and affective diversity were found.

Table 5 shows the hierarchical regressions examining the influence of trait positive affective diversity on group dynamics. Mean TMT trait PA level is significantly positively related to group cooperativeness, but there is no significant effect of affective diversity on cooperativeness. There is, however, a significant interaction effect between mean team trait PA level and trait PA affective heterogeneity. To examine the form of the interaction, we divided the sample into four groups according to a median split on each of the two variables making up the interaction. Figure 2 shows that the interaction comes from the significantly lower level of cooperativeness of groups that are affectively diverse and have a low level of mean trait PA as compared with the other three groups: high mean level trait PA and affectively diverse, high and low mean level of trait PA, and affectively homogeneous.

The results in table 5 for task and emotional conflict are very

similar to those for group cooperativeness. Controlling for the demographic variables (mean tenure level and number of managers from the same university as the CEO), mean trait

PA level had a significant negative effect on task conflict and a marginally significant effect on emotional conflict (p (less than) .10). As with group cooperativeness, no significant main effect of affective diversity was found. There was a significant interaction effect between mean trait PA level and affective diversity for each type of conflict. Figures 3 and 4, which diagram the forms of these two interactions using a median split on both variables, show that the interactions are very similar to each other, and to group coperativemess, with the affectively diverse groups low on mean trait PA being than the others in the level of task and emotional conflict. Thus, hypothesis 3, which predicted that more affectively homogeneous grupos will experience greater coopertiveness and less conflict, was not directly supported. Rather, it was indirectly supported in the context of the interaction: homogeneous groups have equal levels of cooperativeness and task and emotional conflict, regardless of mean trait PA. In contrast, affectively diverse groups that have high mean trait PA levels are characterized by greater cooperativeness and lack of conflict than are affectively diverse groups with low mean trait PA levels. Thus, increased stressful social relationships were found in affectively diverse, low mean trait PA groups as compared with the other three groups.

The results for hypothesis 4 can be seen in table 6. As this variable focused on the CEO's decision-making style, rather than group processes as a whole, we included CEO trait PA in the equation, as well as the degree of difference between the CEO's trait PA and that of the other team members. Controlling for demographic variables (mean TMT member company tenure) in a hierarchical regression, there was no significant effect of CEO trait PA on participativeness in decision-making style. As predicted in hypothesis 4, there was a marginally significant effect of affective diversity in the predicted direction. CEOs who were more similar to the mean trait PA of their senior management team had a marginally significantly more participative than autocratic decision-making style. There was no significant interaction between affective diversity and mean level affect on CEO decision-making style.

As **financial**lt; performance has been discussed as influencing group processes (Ocasio, 1995), we also included this variable as a control in all of the group process variable regressions reported above, but there was no significant relationship between **financial**lt; performance and group cooperativeness, task conflict, emotional conflict, or degree of CEO participativeness.

Lastly, we examined whether affective diversity would hinder (hypothesis 5a) or help (hypothesis 5b) group performance by examining the **financial**lt; performance of the publicly held organizations in our sample. The results are shown in table 7. Controlling for differences from other TMT members in functional background (which was significantly positively related to **financial**lt; performance) and mean trait PA (which was not significantly related to **financial**lt; performance), a hierarchical regression showed that trait PA homogeneity was marginally significantly related to firm **financial**lt; performance. The more affectively diverse the team was in trait PA, the lower the company's logged market-adjusted return over the mean number of years the team had been together. The interaction effect of affective diversity and mean level trait PA on **financial**lt; performance was not significant. Thus, there is marginally significant support for hypothesis 5a, that groups that are homogeneous in their trait PA will have better performance .

As we discussed earlier, group process measures can influence **financial**lt; performance as well, so we entered degree of group cooperativeness, task and emotional conflict, and degree of CEO participativeness as controls in our equation prior to entering the affective diversity variables. None of these variables was found to be significantly related to **financial**lt; performance.

Exploration of Trait Negative Affect

We conducted exploratory hierarchical regression analyses for trait negative affective diversity using the variables described in Appendix B. These analyses were identical to those conducted for trait positive affective diversity. No effects for trait negative affective diversity, either at the individual level or at the group level, were found. There were also no significant effects of mean level negative trait affect on any of the dependent variables.

DISCUSSION

Teams are increasingly becoming primary in the way employees in organizations conduct work (Guzzo and Shea, 1992; Jackson, 1991). The effects of similarities and differences among team members have been shown to influence every aspect of that work. In this study we expanded on the classic examination of demographic differences to include differences in personality and emotion through trait positive affect. We found that trait positive affective diversity does make a difference in individual group members' attitudes, group processes, and group performance. Examining these differences provides a particularly interesting empirical test of the oft-stated rationale for poor team performance: personality clashes, the effects of which have been shown to be particularly strong in group settings (see Mikolic, Parker, and Pruitt, 1997).

The greater the fit in trait positive affect (PA) between top management team members and their fellow team members, the higher their satisfaction with interpersonal relations within the team and the higher their perceptions of their amount of influence on the team. A similar trait PA fit between the CEO and the rest of the team is associated with a marginally significantly greater use of participative than autocratic decision making by the CEO. This marginally greater CEO participativeness is additional evidence that members accurately feel that they have more influence when they are in more affectively homogeneous teams.

When examining group process, we found an intriguing, and unexpected, interaction effect that can be characterized by the first line of Anna Karenina: "All happy families are like one another; each unhappy family is unhappy in its own way" (Tolstoy, 1961: 17). Happy, or high trait PA top management teams, had the same relatively higher levels of cooperativeness and lower levels of task and emotional conflict, regardless of affective diversity. "Unhappy" teams, or teams lower in trait PA, were unhappy in their own way, depending on their level of affective diversity. Low trait PA teams with low affective diversity had levels of cooperativeness and conflict similar to those of the happy teams. But low trait PA teams with high levels of affective diversity were significantly lower in cooperation and higher in conflict than the other three groups. Thus, for group conflict and cooperativeness, being homogeneous compensated for low trait PA, and being high in trait PA compensated for being affectively diverse, but nothing ameliorated the effect of being affectively diverse and having mean low trait PA.

These affective compensatory effects did not extend, however, to company **financial**lt; performance. No interaction between mean level of trait PA or PA diversity was found, and no effects of mean trait positive affect were found: whether a TMT comprised dispositionally happier or sadder members had no relationship with **financial**lt; performance. Rather, there was a marginally significant negative relationship between affective diversity and firm **financial**lt; performance: more affectively diverse top management teams had poorer **financial**lt; performance than did teams more homogeneous in trait PA. This result contrasts with our finding for the effect of a more standard measure of diversity--functional background--on performance. We found that top management team functional heterogeneity was associated with greater **financial**lt; performance, which conforms with literature we cited earlier supporting the positive effects of some types of demographic heterogeneity and empirical findings on top management teams (Hambrick, Cho, and C hen, 1996).

Although the broad nature of our sample (across both industry and sector) generally helped to support the generalizability of our results, it hindered our ability to establish a standardized measure of organizational performance in that we were only able to test the performance hypothesis with the publicly listed firms in our sample. Despite this limitation, and the consequent reduction in the number of organizations in the sample for this hypothesis, our beta was quite large (B = -.30). Accordingly, we believe this result will be even stronger if replicated in a study with a larger sample size or one in which performance is comparable across all organizations. Also, this result is particularly exciting given the inherently loose relationship between top management team dynamics and firm **financial** performance. (3)

Interestingly, when we examined whether the affective-diversity effect on **financial** performance was moderated through group process variables, we found no significant relationships between group process variables and **financial** performance. This is puzzling, but it may be that in dealing with their difficult group processes, affectively diverse group members have an individual-level side-effect of being psychologically distracted, which siphons away their ability to focus well on their task above and beyond the group process losses. Also, as Hackman (1983: 257) pointed out, "Too often managers or consultants attempt to 'fix' a group that has performance problems by going to work directly on obvious difficulties that exist in members' interpersonal processes. And, too often, these difficulties turn out not to be readily fixable because they are only symptoms of more basic flaws in the design of the group or in its organizational context. Process is indeed an important thing, but it is not the only thing." The a ffective diversity and composition of the team is one of these fundamental design aspects.

Although it was not the focus of our study, we found support for the literature showing the importance of mean trait positive affect in group process (e.g., George, 1990) but no support for its impact on group performance. It may be that the costs and benefits of each of the positive and negative affective influence processes we discussed earlier canceled each other out, while the benefits of the affective-similarity process remained constant. Also, the mean trait PA level was quite high among these top management teams, which might be expected, as having high trait PA may be more necessary on a top management team than in other jobs. This does restrict the range here, but it leads to a more conservative test.

As an exploratory test, we also tested for the effects of diversity in trait negative affect (NA) and found no relationships for either trait NA diversity or mean level trait NA measures with any of the outcome variables. Given prior research showing trait NA's explicit lack of relationship with social variables (e.g., McnItyre et al., 1991; Watson et al., 1992), it is disappointing, but not surprising, that trait NA had no effect in this situation. We do not think that this is evidence that negative affect is irrelevant to groups. Rather, we believe that the more general, overarching construct of trait negativity may be more related to internal states and therefore may not be the best type of negative emotion to study in the group context. There may still be fruitful avenues for understanding the roles of other, more social, negative emotions in groups, such as anger and anxiety.

Also, our model focuses on trait positive affect, but only as a first step. We think the model should be equally relevant and extend to other types of affect. The next step in this line of research is to examine other affective variables explicitly. For example, having established that affective traits are important to group composition, we would want to extend this inquiry to the influence of particular affective states. Affect state has been shown to be a very important determinant in forming impressions of people (see Asch, 1946; Hastorf, Schnider, and Polefka, 1970), and affective cues have been used to make inferences about different aspects of a person's personality (e.g., Katz and Braley, 1933). The saying that first impressions count has been supported in this research on

impression formation, which may indicate that studying state affect may be particularly important in groups that stay together for short periods, such as juries or task forces. This is different than in top management teams or other situations in which groups stay together for a longer period of time. The repeated encountering of a person's affective states over prolonged periods is likely to relay both a stronger and more accurate impression of the person, overcoming any false first impressions, and is thus more likely to guide responsive behavior. This is especially true as teams work together over time, as team members get to know the affective personality of their peers, how each other works, and as they accommodate each other's ssocial entrainment (McGrath, 1991). As such, the tenure of the group and of individuals within the group could also become an important component or moderator of the similarity-attraction process as it relates to positive affect at the team level.

When thinking about our results, it is natural to question the causation of the effects between affective team composition and team performance. As our measure of positive affect is a stable and reliable trait (e.g., Watson, Clark, and Tellegen, 1988) shown to be steady over different jobs and time (Staw, Bell, and Clausen, 1986; Watson and Slack, 1993), we find it more likely that it will influence group performance or processes rather than vice versa. Also, while we do not expect a reverse causation of performance on trait PA variables, even if there were such a reverse causation, we would expect it be less related to trait affective diversity and more related to mean level trait PA. Yet even this relationship was not found in this study: there was no relationship between **financial** performance and mean level trait PA. While economic adversity has been shown to influence group processes, for example, leading to either the strengthening of cohesive top management groups or the breaking apart of more fragmente d top management groups (Ocasio, 1995), our model would suggest that this would not occur through a direct influence on trait positive affect but, rather, by its influence on individual perceptions and group social processes, such as cooperation. This is not to say, however, that we do not think performance can influence other types of affective variables that we think should be studied in an affective diversity context. For example, in the more malleable case of mood as the predictor variable, we would fully expect to see a feedback loop between team performance and individual- and group-level mood.

Affective Diversity in Top Management Teams

There were several advantages in studying affective diversity in top management teams in particular. As the work of top management teams almost exclusively involves decision-making tasks, it is similar, in this respect, to much of the classic research on which most of the demography research is based. Also, TMT membership tends to be fairly stable (in our sample TMT members had been with the team for an average of seven years), and TMTs are functionally quite comparable, serving essentially the same collective function across organizations. With regard to understanding executive leadership in particular, we had the rare and fortunate opportunity to conduct our research on existing top management teams and have members of those teams answer (with a remarkable response rate) questions about their personal affect, attitudes, and interpersonal dynamics.

There are some drawbacks to studying top management teams, however, which suggest that it would be useful to replicate this study on other types of teams. First, as compared with teams at lower levels of the organization, these teams were quite homogeneous in some of their internal demographic characteristics (e.g., sex, race, and age), which could influence the effect of affective diversity. The influence of affective diversity in more demographically heterogeneous teams could have interesting implications for the team composition literature. For example, it may show that in such teams, affective diversity is less influential because people are focusing on other differences, such as sex or race. Or, to the contrary, it may serve an ameliorative function, helping people to find affective common ground despite their demographic diversity.

There are similar interesting issues raised when thinking about the role of affective diversity in a cross-cultural context. While there is some debate about the degree of universality of facial expressions (e.g., Russell, 1994; Ekman, 1999), a recent meta-**analysis** by Elfenbein and Ambady (2000) showed that basic emotions can be understood across cultures but that there is an "in-group advantage," in that people from the same culture are capable of understanding each other's emotions better than those from different cultures. This could lead to varying outcomes of affective diversity in different cross-cultural situations, depending on the degree to which people are able to read each other's affective signals accurately. If people can understand each other well affectively, then affective similarity can serve the ameliorative function discussed above, helping to bridge cultural barriers. If, however, people are misinterpreting each other's affective signals, this could lead to even greater problems and an ill usory affective diversity that does not exist and worsens any existing cross-cultural difficulties. There is already some preliminary work showing the importance of looking at how cultural norms, such as individualism and collectivism, interact with demographic characteristics to influence group processes and outcomes (Chatman et al., 1998).

Secondly, replications with a different type of team performance may be useful, since although the top management team is collectively responsible for organizational performance, there are many factors that combine to influence the organization's overall performance and reduce the degree of control the team has over the final outcome. Also, the appropriate measure of performance can vary across organizations. While we were able to gather a measure of **financial** performance for the publicly traded companies in our sample, **financial** performance is not an appropriate measure for some organizations, particularly for not-for-profit or public-sector organizations.

The last drawback to testing our hypothesis in top management teams is that the level of interdependence of the team in producing its outcome can be questionable. There has been considerable debate in the field as to the appropriateness of the label "team" for this collection of individuals or whether "top management group" is a more descriptive label (Hambrick, 1994). The interdependence of the team may well have important consequences for how decisions are made (Michel and Hambrick, 1992) and whether the outcome is a result of any group process or merely comes from individual contributions. Our results indicate that although most of the top management groups in the study do consider themselves to be teams, both paradigms may be valid, and in fact, the level of interdependence and shared decision making may vary systematically. Michel and Hambrick (1992) argued that the level of diversification of the firm determines the degree of integration it needs across business units, which in turn determines the ideal composition of the top management team and the degree to which it acts as a team versus a group of individuals. An additional interpretation suggested by our results is that the degree to which the team acts as a team rather than as a group may be as much due to the affective composition of the group as to the nature of the task at hand, which is consonant with research showing that individuals have to be satisfied with other group members, and be motivated to sustain a relationship with them, to have social integration (Katz and Kahn, 1978; Shaw, 1981). Thus, affective diversity may play an important role in this relationship motivation process, influencing group processes and group outcomes. This leads to one of the practical applications of this study, which is that it can help managers make more informed and complete decisions about the factors to consider when deciding how to put their teams together. It can also aid managerial insight into why and how current teams are functioning, by taking affect and personality explicitly into account.

CONCLUSIONS

This study has ramifications for the literature on emotions in organizations, group composition, and top management teams. For the

literature on emotions in organizations, this study offers an additional conceptualization of the construct of group emotion and shows that affective diversity can influence group dynamics and performance. Our study shows that when examining emotions and personality, one needs to take into account not only the mean affective level of each group member but also the group's affective diversity and the relative similarity, or affective fit, of each member to the other group members. Also, while we focused on the overarching and stable construct of trait positive affect, there are many areas to explore in affective diversity, including moods and more specific emotions such as anger, disappointment, and joy. For the group composition and demography literatures, we offer a new compositional variable, which operates on similarity-attraction principles but differs in its emphasis on affec tive versus cognitive similarity as a reinforcer. Affective diversity may be able to explain contradictory effects in this literature, both in its own right and in its interaction with other demographic variables. At the same time, the fact that we found effects similar to those of attitudinal similarity offers support for the theoretical underpinnings of the team composition literature and shows that similar effects can occur with variables not inherently tied to demographics.

Finally, our study contributes to the growing literature on the dynamics of top management teams, particularly the conditions under which the top management team may act as a team rather than a group, as described above. Also, the use of CEOs and their senior management teams as a sample has relevance for helping to understand executive leadership. This is particularly important given the great impact top management teams can have on organizational outcomes. Furthermore, because of the inherent difficulties in gaining access to top management teams, personality and other psychological variables have been little studied in top management teams (Hambrick, 1994). This does not mean that psychological variables are not important in top management; on the contrary, they may be even more vital at this level. But most likely because of this lack of access, there has been little work on executive personalities, and most of the research that has been done has focused primarily on dysfunctional personalities (see Kets de Vries and Miller, 1986, for a review). We add to this literature on executive personality by focusing on the influence of "normal" personality characteristics. The continuing study of affective diversity can help to deepen our understanding of both the emotional and compositional components of work group functioning. This can help us add to our current knowledge of the influence of demographic, functional, and cognitive diversity through a more fine-grained **analysis**gt; of the influence of psychological personality characteristics and the influence of emotions in groups.

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(*.) The authors would like to thank Rod Kramer, Linda Johanson, and three anonymous ASQ reviewers for their wonderful guidance and fabulous reviews. Thanks also to Donald Gibson, Barry Staw, John Turner, and Batia Wiesenfeld for their comments and help throughout the paper. Partial support for this article came from the Fred Frank Fund. Yale University.

(1.) Mclntyre et al. (1991: 67) reviewed numerous studies showing that trait positive affect (PA), but not negative affect (NA), is related to "diverse indicators of social activity and interpersonal satisfaction," while NA, but not PA, is related to "somatic complaints, psychopathology, and self-reported stress." They tested this finding by examining the effects of two induced social interactions on positive and negative mood. They found that state positive affect (i.e., mood) was influenced significantly by social interaction, while state negative affect was not changed at all. Similarly, Watson et al. (1992) found no consistent relationship between either state or trait negative affect with measures of social activity, while finding a consistent significant relationship between positive state and trait positive affect with social activity. This is likely because negative affect has been strongly related to more internalized states such as stress reaction, alienation, and aggression, as compared with the more ex ternally oriented states of social closeness and social potency with which trait positive affect is related (Almagor and Ehrlich, 1990).

(2.) Undergraduate and graduate school prestige was coded as follows: 2 = institution ranks among the top 25 national universities or

liberal arts colleges (or the top 25 graduate/professional schools for graduate-school prestige variable); 1 = university is ranked lower than 25th; and 0 = TMT member did not complete a Bachelor's degree (or M.B.A., or other advanced degree for graduate school variable). We used rankings from U.S. News and World Report, October 4, 1993, and U.S. News and World Report, March 21, 1994, for undergraduate and graduate institutions, respectively, to calculate these ratings.

(3.) We attempted to control for outside impacts on performance. We used market-adjusted stock returns, thereby controlling for movements in the market and the general economic factors that affect all firms in the industry. We recognize, however, that organizational performance is still influenced by other factors internal and external to the firm that are outside the control of the top management team.

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Descriptives of Demographic Variables for
Top Management Team Study

Company and top management team characteristics	%	Mean	S.D.	Min.
Type of company				
% Publicly held	58			
% Private (for profit)	32			
% Not for profit	10			
Company age (years)		40.46	38.24	1
Mean years TMT has been together		7.00	4.11	1
Company size index (1-10; publicly held companies only)		9.35	1.04	6
Company market-adjusted return (publicly held companies only)		.038	.209	-0.532
CEO individual level				
Functional background				
General management	37			
Finance	11			
Operations	9			
Marketing	17			
Human resources	0			
Legal	0			
Accounting	6			
Entrepreneur	11			
Other	9			
Sex				
Male	97			
Female	3			
Educational attainment				

High school degree or less	3			
College degree	25			
MBA/graduate degree	72			
Age		52.31	7.87	31
Tenure with company (years)		13	10.89	1
Tenure on TMT (years)		7.37	6.58	(less than) 1
University prestige (0 = no undergrad.;1 = 2d tier; 2 = top tier)		1.25	0.51	0
TMT individual level (not including CEO)				
Functional background				
General management	35			
Finance	17			
Operations	13			
Marketing	12			
Human resources	8			
Legal	5			
Accounting	4			
Entrepreneur	2			
Other	4			
Sex				
Male	89			
Female	11			
Educational attainment				
High school degree or less	3			
College degree	47			
MBA/graduate degree	50			
Attended same undergrad. college as CEO (yes)	4			
Attended same undergrad. college as another TMT member (yes)	14			
Age		48.72	9.54	29
Tenure with company (years)		13.32	8.11	1
Tenure on TMT (years)		7.28	4.06	1
University prestige (0 = no undergrad.;1 = 2d tier; 2 = top tier)		1.15	0.53	0

Company and top management team characteristics	Max.	N
Type of company		
% Publicly held		
% Private (for profit)		
% Not for profit		
Company age (years)	147	61
Mean years TMT has been together	17	62
Company size index (1-10; publicly held companies only)	10	34
Company market-adjusted return (publicly held companies only)	0.946	36
CEO individual level		
Functional background		
General management		20
Finance		6
Operations		5
Marketing		9
Human resources		0
Legal		0
Accounting		3
Entrepreneur		6
Other		5
Sex		

Male		59
Female		2
Educational attainment		
High school degree or less		2
College degree		15
MBA/graduate degree		43
Age	67	53
Tenure with company (years)	43	61
Tenure on TMT (years)	27	51
University prestige (0 = no undergrad.;1 = 2d tier; 2 = top tier)	2	59
TMT individual level (not including CEO)		
Functional background		
General management		73
Finance		35
Operations		26
Marketing		25
Human resources		17
Legal		10
Accounting		8
Entrepreneur		4
Other		8
Sex		
Male		184
Female		22
Educational attainment		
High school degree or less		7
College degree		105
MBA/graduate degree		113
Attended same undergrad. college as CEO (yes)		218
Attended same undergrad. college as another TMT member (yes)		200
Age	91	216
Tenure with company (years)	37	239
Tenure on TMT (years)	17	239
University prestige (0 = no undergrad.;1 = 2d tier; 2 = top tier)	2	227

Means, Standard Deviations, and Correlations among Individual-Level Top Management Team (TMT) Variables (*)

Variable	Mean	S.D.	1
1. Difference in tenure from other TMT members (+)	5.21	4.71	
2. Undergraduate prestige (+)	1.15	.53	-.04 (209)
3. Difference in undergraduate prestige from other TMT members (+)	0.61	.40	-.01 (201)
4. Trait positive affect (PA) (+)	5.48	.80	.02 (213)
5. Mean level trait PA of other TMT members (+)	5.53	.41	.16 (#) (213)
6. Mean perceived TMT positive culture (+)	5.68	1.21	.18 (##) (214)
7. Individual-level affective diversity	1.01	.45	-.16 (#) (213)
8. Interpersonal satisfaction with the TMT	5.55	1.16	.16 (#) (213)
9. Perceived influence on TMT	5.86	1.27	.05 (213)

Variable	2	3

1. Difference in tenure from other TMT members (+)		
2. Undergraduate prestige (+)		
3. Difference in undergraduate prestige from other TMT members (+)	.06 (224)	
4. Trait positive affect (PA) (+)	.00 (226)	.03 (223)
5. Mean level trait PA of other TMT members (+)	.06 (226)	.04 (223)
6. Mean perceived TMT positive culture (+)	-.01 (227)	-.03 (224)
7. Individual-level affective diversity	.01 (223)	.03 (223)
8. Interpersonal satisfaction with the TMT	-.03 (226)	-.14 (#) (223)
9. Perceived influence on TMT	.14 (#) (223)	-.04 (223)

Variable	4	5
1. Difference in tenure from other TMT members (+)		
2. Undergraduate prestige (+)		
3. Difference in undergraduate prestige from other TMT members (+)		
4. Trait positive affect (PA) (+)		
5. Mean level trait PA of other TMT members (+)	.04 (238)	
6. Mean perceived TMT positive culture (+)	.35 (###) (238)	.03 (238)
7. Individual-level affective diversity	-.39 (###) (235)	-.24 (###) (235)
8. Interpersonal satisfaction with the TMT	.37 (###) (237)	-.04 (237)
9. Perceived influence on TMT	.27 (###) (237)	-.10 (237)

Variable	6	7
1. Difference in tenure from other TMT members (+)		
2. Undergraduate prestige (+)		
3. Difference in undergraduate prestige from other TMT members (+)		
4. Trait positive affect (PA) (+)		
5. Mean level trait PA of other TMT members (+)		
6. Mean perceived TMT positive culture (+)		
7. Individual-level affective diversity	-.11 (235)	
8. Interpersonal satisfaction with the TMT	.67 (###) (238)	-.22 (###) (234)
9. Perceived influence on TMT	.45 (###) (238)	-.17 (##) (234)

Variable	8
1. Difference in tenure from other TMT members (+)	
2. Undergraduate prestige (+)	
3. Difference in undergraduate prestige from other TMT members (+)	
4. Trait positive affect (PA) (+)	
5. Mean level trait PA of other TMT members (+)	
6. Mean perceived TMT positive culture (+)	
7. Individual-level affective diversity	
8. Interpersonal satisfaction with the TMT	
9. Perceived influence on TMT	.56 (###) (237)

(#.)p (less than) .05;
(##.)p (less than) .01;
(###.)p (less than) .001; two-tailed tests.
(*.)Numbers in parentheses are numbers of TMT respondents.
(+.)Includes CEO response (otherwise TMT responses only).

Means, Standard Deviations, and Correlations among Group-level Top Management Team (TMT) Variables (*)

Variable	Mean	S.D.	1	2
1. Mean tenure on TMT (+)	7.00	4.11		
2. Mean TMT tenure at company (+)	12.57	7.97	.69 (###) (62)	
3. Mean number of managers from CEO's university	0.05	0.12	.00 (61)	
4. Difference in TMT functional backgronds(+)	0.55	0.21	.02 (62)	.10 (62)
5. Individual CEO trait positive affect (PA) (+)	5.67	0.66	.12 (59)	.16 (59)
6. Mean level trait PA of other TMT members (+)	5.51	0.37	.09 (62)	.05 (62)
7. Difference in CEO trait PA and TMT trait PA (+)	0.94	0.38	-.08 (62)	-.01 (59)
8. Group-level affective diversity (+)	0.71	0.25	-.08 (62)	-.03 (62)
9. Mean TMT emotional conflict	3.42	1.11	-.30 (#) (62)	-.32 (##) (62)
10. Mean TMT task conflict	3.54	0.89	-.25 (#) (62)	-.27 (#) (62)
11. Mean TMT cooperativeness	5.26	0.63	.06 (20)	.05 (20)
12. Mean CEO participative vs. autocratic decision-making style	5.90	1.18	.15 (62)	.22 (62)
13. Mean company annual market-adjusted return	0.038	0.209	-.05 (36)	-.11 (36)

Variable	3	4	5
1. Mean tenure on TMT (+)			
2. Mean TMT tenure at company (+)			
3. Mean number of managers from CEO's university			
4. Difference in TMT functional backgronds(+)			
5. Individual CEO trait positive affect (PA) (+)	.00 (59)	.02 (59)	
6. Mean level trait PA of other TMT members (+)	.12 (61)	-.17 (62)	.47 (###) (59)
7. Difference in CEO trait PA and TMT trait PA (+)	.33 (##) (59)	.20 (59)	-.07 (59)
8. Group-level affective diversity (+)	.19 (61)	.19 (62)	-.16 (59)
9. Mean TMT emotional conflict	-.33 (##)	-.02	.04

	(61)	(62)	(59)
10. Mean TMT task conflict	−.25 (#)	−.10	.03
	(61)	(62)	(59)
11. Mean TMT cooperativeness	.36	.29	−.22
	(20)	(20)	(19)
12. Mean CEO participative vs. autocratic decision-making style	.01	−.04	−.03
	(61)	(62)	(59)
13. Mean company annual market-adjusted return	−.07	.40	.00
	(36)	(36)	(35)

Variable	6	7	8
1. Mean tenure on TMT (+)			
2. Mean TMT tenure at company (+)			
3. Mean number of managers from CEO's university			
4. Difference in TMT functional backgronds(+)			
5. Individual CEO trait positive affect (PA) (+)			
6. Mean level trait PA of other TMT members (+)			
7. Difference in CEO trait PA and TMT trait PA (+)	−.39 (##)		
	(59)		
8. Group-level affective diversity (+)	−.47 (###)	.84 (###)	
	(62)	(59)	
9. Mean TMT emotional conflict	−.22	.00	.07
	(62)	(59)	(62)
10. Mean TMT task conflict	−.30 (##)	.10	.14
	(62)	(59)	(62)
11. Mean TMT cooperativeness	.38	.11	.00
	(20)	(19)	(20)
12. Mean CEO participative vs. autocratic decision-making style	.19	−.17	−.21
	(62)	(59)	(62)
13. Mean company annual market-adjusted return	−.09	−.12	−.14
	(36)	(35)	(36)

Variable	9	10	11	12
1. Mean tenure on TMT (+)				
2. Mean TMT tenure at company (+)				
3. Mean number of managers from CEO's university				
4. Difference in TMT functional backgronds(+)				
5. Individual CEO trait positive affect (PA) (+)				
6. Mean level trait PA of other TMT members (+)				
7. Difference in CEO trait PA and TMT trait PA (+)				
8. Group-level affective diversity (+)				
9. Mean TMT emotional conflict				
10. Mean TMT task conflict	.84 (###)			
	(62)			
11. Mean TMT cooperativeness	.74 (###)	−.73 (###)		
	(20)	(20)		
12. Mean CEO participative vs. autocratic decision-making style	−.33	−.27 (#)	.21	
	(62)	(62)	(20)	

13. Mean company annual market-adjusted return	.07	.01	.68	-.07
	(36)	(36)	(6)	(36)

(#.)p (greater than) .05;
(##.)p (greater than) .01;
(###.)p (greater than) .001;
two-tailed tests.
(*.)Numbers in parentheses are numbers of TMT respondents.
(+.)Includes CEO response (otherwise TMT responses only).

Hierarchical Regression of Individual-level Affective Diversity of TMT Members on Individual-level Satisfaction with the Group and Self-perceptions of Influence (*)

Variable	Interpersonal satisfaction with the TMT 1	Perceived influence on TMT 2
Difference in tenure from other TMT members	.15 (##)	-
Difference in prestige of undergrad. university from other TMT members	-.14 (#)	-
Prestige of undergraduate university	-	.14 (#)
Contribution to (R.sup.2)	.04	.02
Trait positive affect (PA)	.17 (###)	.13 (#)
Perceived TMT positive culture	.60 (###)	.41 (###)
Mean PA level of other team members (+)	-.06	-.12 (#)
Contribution to (R.sup.2)	.45	.23
Difference in PA from other TMT members (+)	-.11 (#)	-.14 (##)
Conribution to (R.sup.2)	.01	.02
Interaction of mean level TMT PA and PA diversity	.07	-.11
Contribution to (R.sup.2)	.00	.01
Overall F-ratio	29.09 (###)	13.55 (###)
Adjusted (R.sup.2)	.49	.25
N	209	223

(#.)p (less than) .05;
(##.)p (less than) .01;
(###.)p (less than) .001;
one-tailed tests; interactions are two-tailed tests.
(*.)Entries represent standardized coefficients
and are reported in the order entered.
(+.)Includes CEO response (otherwise TMT responses only).

Hierarchical Regression of Affective Diversity in TMT Trait PA on TMT Cooperativeness and Task and EmotionalConflict (*)

Variable	Group cooperativeness 1	Task conflict 2
Mean TMT tenure (+)	--	-.25 (#)
Mean number of managers from CEO's university	--	-.25 (#)
Contribution to (R.sup.2)	--	.13
Mean trait PA level of TMT (+)	.38 (#)	-.26 (#)
Contribution to (R.sup.2)	.14	.06
Heterogenity in TMT PA (+)	.23	.06
Contribution to (R.sup.2)	.04	.00
Interaction of mean level TMT PA		

and PA diversity	.64 (###)	-.24 (#)
Contribution to (R.sup.2)	.39	.06
Overall F-ratio	7.33 (###)	3.65 (##)
Adjusted (R.sup.2)	.50	.18
N	20	61

Variable	Emotional conflict 3
Mean TMT tenure (+)	-.30 (##)
Mean number of managers from CEO's university	-.33 (###)
Contribution to (R.sup.2)	.20
Mean trait PA level of TMT (+)	.16
Contribution to (R.sup.2)	.03
Heterogenity in TMT PA (+)	.04
Contribution to (R.sup.2)	.00
Interaction of mean level TMT PA and PA diversity	-.24 (#)
Contribution to (R.sup.2)	.06
Overall F-ratio	4.34 (##)
Adjusted (R.sup.2)	.22
N	61

(#.)p (less than) .05;
(##.)p (less than).01;
(###.)p (less than).001; one-tailed tests;
interactions are two-tailed tests.
(*.)Entries represent standardized
coefficients and are reported in the orderentered.
(+.)Includes CEO response (otherwise TMTresponses only).

Hierarchical Regression of Positive Affective Diversity on CEOs' Participative vs. Autocratic Decision-making Style (N = 59) (*)

Variable	CEO participativeness in decision-making style
Mean TMT company tenure	.23 (#)
Contribution to (R.sup.2)	.05
CEO's trait PA	-.07
Contribution to (R.sup.2)	.01
Difference between CEO and individual team members' PA	-.17 (#)
Contribution to (R.sup.2)	.03
Interaction of CEO PA and PA diversity	-.15
Contribution to (R.sup.2)	.02
Overall F-ratio	1.55 (#)
Adjusted (R.sup.2)	.04

(#.)p (less than) .10; tests of hypotheses are one-tailed;
other tests are two-tailed.
(*.)Entries represent standardized coefficients
and are reported in the order entered.

Hierarchical Regression of Positive Affective Diversity on Logged Company Market-adjusted Returns Averaged across Number of Years Team Worked Together (N = 36) (*)

Variable	Logged market-adjusted return
Difference in functional background from other TMT members (+)	.40 (**)
Contribution to (R.sup.2)	.16
Mean trait PA level of the TMT (+)	-.03
Contribution to (R.sup.2)	.00
Heterogeneity in TMT PA (+)	-.30 (*)

Contribution to (R.sup.2)	.07	
Interaction of mean level TMT PA and PA diversity	-.01	
Contribution to (R.sup.2)	.00	
Overall F-ratio	2.34	(*)
Adjusted (R.sup.2)	.13	

(*.)p(less than).10; (**.)p(less than).05; two-tailed tests.

(*.)Entries represent standardized coefficients and are reported in the order entered.

(+.)Includes CEO response.

APPENDIX A: Negative Affective Team Composition Variables

Individual trait negative affect (NA) We used the 14-item Stress Scale from the Multidimensional Personality Questionnaire (MPQ), formerly called the Differential Personality Questionnaire (Tellegen, 1982), to measure trait negative emotionality. Sample items are "I often get irritated at little annoyances," "I sometimes get myself into a state of tension and turmoil as I think of the day's events," and "I sometimes feel 'just miserable' for no good reason." The scale has been found to be a highly reliable and valid measure of the underlying NA construct (Tellegen, 1982). The scale was administered using a 7-point Likert-type scale in place of the original true-or-false format for greater response range. The scale mean was 2.79 (s.d. = 1.06), and the Cronbach alpha reliability was .89.

Negative affective diversity. Similar to positive affective diversity, we measured negative affective diversity through heterogeneity in trait negative affect at both the individual and team level. The mean trait NA relational demography score for the entire top management team (including the CEO) was 1.39 (s.d. .57). We also used each CEO's trait NA relational demography score separately as the predictor variable for affective diversity when examining the CEO's participative decision-making style. The mean trait NA relational demography score for the CEOs was 1.34 (s.d. = .66). We used the standard deviation of the top management teams trait NA to measure negative affective diversity (x 1.03, s.d. = .38).

Mean level trait negative affect. We calculated group-level trait negative affect as the average of the team members' trait NA scores, including the CEO (x = 2.81, s.d. = 52). For individual-level analyses, we calculated a variable to control for the trait NA of the other members of the team. This variable represents the mean trait NA of everyone minus the self (x = 2,79, s.d. = 1.06).

Perceived group negative affective culture. To control for perceptual biases in the individual-level analyses, we measured top management team members' (not including the CEO) perceptions of the negative affective culture in their top management team by having them rate the following items: "The emotional culture of our top management team is nervous, irritable, and distressed," and "The emotional culture of our top management team is calm and serene" (reverse coded). A perceived team negative culture score was calculated for each top management team member by taking his or her mean rating on both items (scored on a 7-point Likert scale; 1 = Strongly Disagree through 7 = Strongly Agree). The mean perceived team negative culture score was 3.59 (s.d. = 1.37), and the Cronbach alpha reliability was .64.

APPENDIX B: CEO Participative Leadership Scale

Our CEO participative-leadership-style scale measured each CEO's degree of participativeness versus autocracy as rated by their top management teams. Top management team members were asked about the degree of participativeness of their CEO when dealing with the following 17 organizational issues: acquisition of major capital, change in resource allocation processes, allocation of capital, changes in operating budgets, corporate **financing**, corporate relocations or locations of new plants/offices, human resource strategy, corporate acquisitions, addition of a product line, deletion of a product line, emphases of particular

product lines, marketing strategy, overall strategic direction, hiring members of the TMT, firing members of the TMT, international expansion, and changes to the organizational structure. Senior managers rated CEO participativeness on a 5-point response scale adapted from Heller (1971): 1 = CEO makes the decision alone without a detailed explanation to the TMT; 2 = CEO makes the decision alon e with a detailed explanation to the TMT; 3 = CEO consults with the TMT and then makes the decision, which may or may not concur with the recommendations made by the TMT; 4 = there is joint decision making between the CEO and the TMT, the entire team, including the CEO, reaches consensus, and the team's decision is implemented; and 5 = the CEO delegates the decision-making responsibility to the top management team. We calculated the final CEO participative style decision-making score by recoding the five responses using the weighted scale (recoded as 0, 1, 5, 8, and 10, respectively) as recommended by Vroom and Yetton (1973), calculating the mean of the weighted 17 items for each senior manager's assessment of his or her CEO (Cronbach alpha = .90) and then aggregating the ratings across the senior management team to form a group-level score for each CEO (x= 5.90, s.d. = 1.18).

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Industry Codes/Names: BUSN Any type of business
Descriptors: Workplace multiculturalism--Psychological aspects; Organizational behavior --Research; Employee motivation--Social aspects; Industrial psychology-- Research
Geographic Codes: 1USA United States
Product/Industry Names: 9918200 (Employee Relations)
File Segment: MC File 75

30/9/9 (Item 9 from file: 148)
13396478 Supplier Number: 70190885 (THIS IS THE FULL TEXT)
Do taxes influence where U.S. corporations invest?

Grubert, Harry; Mutti, John
National Tax Journal , 53 , 4 , 825
Dec , 2000
ISSN: 0028-0283
Language: English
Record Type: Fulltext; Abstract
Word Count: 6995 Line Count: 00552
Author Abstract: This paper uses data aggregated from tax returns of more than 500 U.S. multinational corporations (MNCs) to identify the role of host country tax rates in determining the amount of capital invested in 60 potential locations. The empirical results show that average effective tax rates have a significant effect on the choice of a location and the amount of capital invested there. A lower tax rate that increases the after-tax return to capital by one percent is associated with about 3 percent more real capital invested if the country has an open trade regime. The attractive power of low tax rates is weakened if the country has a more restrictive trade regime. Approximately 19 percent of U.S. capital abroad would be in a different location in the absence of any effect of taxes.

Text:

INTRODUCTION

Much of international tax policy rests on judgments regarding the allocation of capital in response to tax differences among alternative locations. A primary objective of this paper is to assess the responsiveness to taxes of the locational choices abroad of U.S. multinational corporations (MNCs). The empirical **analysis** is based on data from the U.S. Treasury 1992 corporate tax files, which cover the activities of more than 500 major U.S. manufacturing companies in 60 potential foreign locations. The results reported here rest on data aggregated for each country location, and they demonstrate that local average effective tax rates have a significant effect on the amount of capital that U.S. MNCs have in a given location. For a country with an open trading regime, the elasticity of total real capital with respect to a reduction in the host country tax rate that increases the after-tax return by 1 percent is about three.

A number of papers have analyzed the sensitivity to taxes of foreign direct investment (fdi) into and out of the United States. Early examples of this work based on aggregate data include Hartman (1984), Boskin and Gale (1987), and Slemrod (1990).(1) They have generally found significant tax impacts, but these studies suffer from two major limitations. One is that they relate the annual flow of fdi to the level of current or lagged tax rates. Basic models of firm behavior indicate that there will be a long-run equilibrium relationship between the stock of capital and the level of the cost of capital, not between the annual flow of new investment (or the change in the stock) and the level of the cost of capital. Therefore, a more appropriate **analysis** would either estimate a stock equation or demonstrate what adjustment costs and tax changes are relevant in determining annual changes in the stock. Furthermore, fdi, which is the change in direct equity abroad, is an inappropriate measure for real investment, because it may simply represent **financing** or repatriation behavior. Indeed, in their study of U.S. direct investment in Canada, Grubert and Mutti (1991b) find that variations in fdi and plant and equipment spending are virtually uncorrelated.

Studies based on real investment at the firm level, derived from Standard and Poor's Compustat, have asked somewhat different questions. Harris (1993) analyzes the impact of the Tax Reform Act of 1986 based on a 0-1 categorization of firms expected to face a large increase in their tax burden. Cummins and Hubbard (1995) focus on the short-run response of U.S. firms investing abroad.(2) Devereux and Griffith (1998) are able to avoid some of the ambiguities that Cummins and Hubbard face in measuring changes in capital spending by considering the choice of U.S. MNCs to locate in three European countries over the period 1980-94. From all of these papers, however, it is difficult to derive implications for the way aggregate stocks and flows of capital will be affected by tax policy changes, such as those reported in the opening paragraph.

Two cross-sectional studies that evaluate the relationship between real capital stocks and local tax rates are most closely related to the present paper. In a study of U.S. manufacturing affiliates in 33 foreign countries based on 1982 data from The Benchmark Survey of U.S. Direct Investment Abroad, Grubert and Mutti (1991a) find that a 1 percent reduction in the cost of capital increased the stock of U.S. owned net plant and equipment by 1.5 percent. Hines and Rice (1994) use that same data source but also include all non-bank affiliates in a larger group of countries. In two different formulations they obtain corresponding elasticities with respect to a 1 percent change in the cost of capital equal to 2.3 and 4.5. Because their country sample includes a large number of tax havens with tiny populations, however, there may be many cases in which the real capital owned by an affiliate incorporated in a low-tax location is actually used in a branch somewhere else.

This paper uses a different and more recent data source to carry out a cross-sectional **analysis** of the relationship between real

capita stock and local tax rates. It confirms that the responsiveness of capital to taxes is substantial in many alternative specifications. This result continues to hold when very poor or very low tax countries are excluded from the group of potential locations. Also, it holds if the tax rate is represented by an average for 1990 and 1992, to avoid the noise of a measure calculated for a single year, or if it is adjusted for possible dependence on the amount of recent investment in a country.

Countries with more restrictive trade regimes obtain less of a benefit from lower tax rates in attracting U.S. investment. The tax responsiveness of investment declines. This is consistent with the importance of production for other foreign markets, because more restrictive trade regimes increase the relative cost of exports. If current stocks of investment are used to weight the estimated responses for each trade regime, the corresponding overall elasticity is two.

A FRAMEWORK FOR EMPIRICAL **ANALYSIS**

MNC investment generally occurs when a firm expects that locating production abroad will allow it to earn a higher return from some special expertise it possesses. Basic models that demonstrate the determinants of an MNC's optimal capital stock in a given country location are presented by Grubert and Mutti (1991a) and by Hines and Rice (1994). These models generally depend upon a scale variable that reflects the size of the market to be served and upon the costs of capital, labor, and other variable inputs).(3) For a firm to earn the same after-tax return to capital in all locations, the before-tax cost of capital is higher in a location where a higher tax rate applies; a higher tax rate results in a smaller optimal capital stock. Other relevant variables include tariffs and transport costs and plant-specific fixed costs. Foreign production becomes a more attractive way of serving the foreign market as foreign production costs and plant-specific fixed costs are lower and as transport costs and trade barriers are higher (Horstmann and Markusen, 1992).

The primary issue addressed in this paper is the responsiveness of the amount of real capital invested by MNCs in manufacturing affiliates in a given country to the rate of taxation on the income earned in that country. The data are aggregated over all firms in the country to create a single observation, as if there were a single firm. The choice of this firm in deciding where to invest among several competing locations to serve a given market might be expressed in the following general form:

(1) $K_j = f(Y, r, t_1, t_2, \ldots t_N, X_1, X_2, \ldots X_N)$

where K_j is amount of real capital located in country j, Y represents the scale of the market served, r is the common after-tax return earned in all locations, t_j is the tax rate in country j, and X_j represents all other variables that vary by location j.

There are insufficient degrees of freedom to consider each competing location separately, and a convenient simplification is to consider an average of these alternative rates. Expressing this relationship in a logarithmic form gives the following equation:

(2) $\log K_i = a + b \log((1 - t_i)/(1 - t_A)) + c \log((1 - t_i)/(1 - t_{us})) + d \log X_i + e \log N$,

where t_A is the average tax rate over all foreign locations, t_{US} is the U.S. effective tax rate, and N is the number of relevant foreign locations. The role of host country taxation enters in the form $(1 - t_i)$, which means that the coefficient b is an elasticity indicating the percentage change in capital located in country i in response to a 1 percent change in the after-tax return in location i for a given pre-tax return, or, equivalently, to a 1 percent change in the cost of capital for a given after-tax return.

This formulation assumes that the competition offered by other locations, apart from the United States, is fully represented by the number of potential locations, N, and their mean tax rate. If the number of potential foreign locations is large, the average tax rate is the same regardless of which country i is considered. The importance of this average

tax rate and the U.S. tax rate then are subsumed in the constant term, because they are fixed in the cross section. Although the two different relative tax rates are explicitly shown in equation (2) to indicate that the capital located in country i may be attracted from other foreign locations and from the United States, the two $\log(1 - (t_i))$ terms can be grouped together:

(3) $\log (K_i) = f + g \log(1 - (t_i)) + d \log (X_i)$

which is the equation estimated by ordinary least squares in this study.(4)

Equation (3) expresses the desired capital stock in country i as a function of the host country tax rate and the vector of country characteristics. Of course, potential locations may not be regarded as equally likely, due to differences in the proximity to the relevant market or the availability of particular factor endowments. That possibility is considered by introducing a set of regional dummies for North America, Latin America, Asia, and the EC. These dummies are entered as independent variables and are also interacted with the tax rate to assess whether there is greater sensitivity to taxes in neighboring locations with access to the same market.(5)

With respect to other country characteristics, gross domestic product (GDP) and GDP per capita are included as possible indicators of the size of the domestic market, where the latter variable is particularly relevant for goods whose demand is income elastic. Higher per capita income may also reflect a more skilled labor force that can be employed in high-technology industries, and we attempt to measure that effect independently by including a human capital variable that gives the percentage of the university-age cohort who receive higher education. An indicator of openness of the economy is entered as an independent variable and also interacted with the tax variable, in order to assess whether countries with more restrictive trade regimes and less potential to benefit from a more competitive position in export markets get less benefit from lower tax rates.

RELEVANT CONCEPTS OF TAXATION

The income tax rate used in the empirical **analysis** is the observed average rate for a given host country. An important consideration is the potential superiority of Hall-Jorgenson marginal effective tax rates. Unfortunately, such marginal tax rates are not available for all of the 60 countries in the **analysis**. Furthermore, the Hall-Jorgenson-King-Fullerton (HJKF) type generally are based on a limited number of features of the tax system, in particular the statutory tax rate, the amount of accelerated depreciation on tangible investments, and investment tax credits. In many host countries companies are offered special ad-hoc deals that are difficult to identify simply from basic statutory provisions. In contrast, the country average tax rates computed from the Treasury files reflect all provisions of the tax system as well as special arrangements. Because of the importance of the taxation of infra-marginal rents that can be earned from production in a given location compared to their taxation in alternative locations, the average tax rate may even be the preferable indicator of the incentive to locate in a country.

Another potentially relevant issue is whether there is a residual tax due in the United States, which in turn depends upon the parent's expected foreign tax credit position. Under U.S. law, active foreign income received by U.S. corporations is taxed when repatriated, with a credit for foreign taxes including both withholding taxes and the underlying foreign corporate tax on equity income if the U.S. company owns at least 10 percent of the foreign company. The credit for foreign tax is limited, however, to what the U.S. tax would be on the equivalent income.

If the parent company does not expect to have excess credits, then the residual U.S. tax on potential repatriations may become relevant. Hartman (1984) and Sinn (1993) have claimed, however, that the repatriation tax should be irrelevant for investment by a mature controlled foreign

corporation (CFC), in an **analysis** that parallels the irrelevance of individual income taxes on dividends in the "new view" in a domestic context. If residual U.S. taxes are relevant, they will tend to narrow tax differentials between locations because the U.S. repatriation tax would be higher on distributions from low-tax countries.

If the firm expects to have excess credits, then the marginal effective tax rate on equity income is the host country rate, including withholding taxes on any distributions. Interest and royalties, however, which are generally deductible in the host country, will be exempt in the United States because they are foreign source and can be shielded by the excess credits. A CFC may respond to a high statutory tax rate by increasing its debt-to-asset ratio, or by paying more royalties to the parent, thereby generating greater deductible expenses in the host country and diluting the deterrent effect of high local taxes. Ignoring residual U.S. taxes and debt **finance**, and using only the local tax rate, may bias downward the estimated tax responsiveness of MNCs, because the variation in the tax burden across locations is less than implied by the local rate.

DATA SOURCES AND MEASUREMENT ISSUES

The principal data base was the linked Forms 1120, 5471, and 1118 for 1992. Form 1120 is the basic U.S. corporate income tax return and provides information on the parent's income, expenses, and assets. The Form 5471 is an information return that MNC parents are required to file for CFC that gives its earnings and profits, balance sheet, sales, foreign taxes paid or accrued, and transactions with affiliates. A CFC is defined as a foreign company, more than 50 percent of which is owned by U.S. shareholders.(6) The Form 1118 is used by a parent MNC when claiming a foreign tax credit to reduce its U.S. tax liability.

The MNC parents in the sample are all U.S. companies in manufacturing with total assets in excess of $500 million that have at least one CFC. Altogether there turned out to be 561 parent companies whose data were available. Sixty potential foreign locations were used in the **analysis**, which were all the countries with more than five manufacturing CFCs in 1990.(7) The **analysis** was restricted to manufacturing CFCs of manufacturing parents.

CFC assets on the Form 5471 balance sheet are reported according to general U.S. accounting principles. They are not distorted by host country incentives such as accelerated depreciation. They are **historical** book values, however, which can be distorted by inflation. This disadvantage of using **historical** book values may warrant attention to the number of companies that choose to locate in a country, without considering the amount invested there, or to the sales made from that location.

Average host country corporate tax rates are derived from the Form 5471s by taking total income taxes paid by manufacturing CFCs incorporated in that country divided by their total "Earnings and Profits." The latter, defined in the Internal Revenue Code, is intended to reflect net economic income, not host country (or domestic U.S.) taxable income, which is affected by incentives such as accelerated depreciation. In this calculation, only those CFCs with positive income are included, because otherwise the tax measure will be biased upward. This approach yields 60 country average effective tax rates; firm-specific rates are not calculated, because they are not known for locations that are not chosen or where negative profits are earned.

Data for GDP and population (in 1990) are from the World Bank World Development Report 1992, supplemented in a few cases by information from The World Factbook 1992 published by the Central Intelligence Agency. The human capital variable indicating the share of the country's university-age cohort receiving higher education also is from the World Development Report.

The measure of the country's trade restrictions, running from zero (for the most open) to three, is based on four degrees of trade policy

openness reported in the World Bank World Development Report 1987 (page 83). The Report states that the classification is based on: (a) the country's effective rate of protection, (b) its use of direct controls such as quotas, (c) its use of export incentives, and (d) the extent of any overvaluation of its exchange rate. The measure thus reflects more than trade restrictions and in particular may include the effect of any capital controls that allow an over-valued exchange rate.

EMPIRICAL RESULTS

Ordinary least squares estimates of equation (3) based on the 60 country locations where at least five MNC manufacturing affiliates operate are reported in Table 1. Column 1 shows that average effective tax rates have a significant effect on the amount of capital invested in a country. The elasticity with respect to a 1 percent change in the cost of capital, or a 1 percent change in the after-tax return for a given pre-tax return, is 3.23 for countries with the most open trade regime. For those countries the interaction of the tax rate with the trade regime is zero and therefore irrelevant in determining the effect on real capital. The coefficient for the interaction of the trade regime and tax variables shows that more restrictive regimes benefit less from a lower tax rate. Because of this moderating impact of trade restrictions on responsiveness to tax rates, the comprehensive elasticity of real capital with respect to the tax variable, created by weighting each country's trade-policy-influenced elasticity by the U.S. capital invested there, is two.(8)

(TABULAR DATA 1 NOT REPRODUCIBLE IN ASCII)

The second column of Table 1 allows an assessment of whether there is a magnified impact of low tax rates on capital allocation decisions, rather than a constant proportional effect as assumed with the log (1 - t) specification. The inverse (0.1 plus the average effective tax rate) is used as the tax variable, where the somewhat arbitrarily chosen **value** 0.1 avoids the extreme values that otherwise would be created at very low tax rates. In this form, taxes are more significant statistically and the overall equation has more explanatory power. The magnified sensitivity at low tax rates may represent a response to the incentive to shift income to low tax countries. Note that the coefficient on the trade openness variable is now positive, but its interaction with the tax variable still shows that restrictive policies weaken the response to low taxes.

The regression in column 3 uses the 1992 effective tax rate that has been adjusted for differences in the age composition of the companies in each location. Such an adjustment corrects for a potential bias or endogeneity of the average effective tax rate, because that rate is likely to be lower if there has been a large amount of recent investment. Large recent investments that benefit from investment tax credits would be particularly likely to indicate a spurious relationship between low tax rates and a large amount of capital in a location. Although the current **analysis** deals with the stock of capital and not the yearly change, the book **value** of capital nevertheless may be affected by large recent investments, too.

Examination of the individual CFC data indicates that there is a clear age effect; CFCs incorporated recently have significantly lower effective tax rates than the country average. Although one way to control for endogeneity is to apply an instrumental variable approach that gives a predicted **value** of taxes based on their relationship to another country-level exogenous variable, a preferable approach here, given our access to firm-level data, is to make an hedonic adjustment of the tax variable. Based on the coefficients from CFC-level regressions of affiliate taxes on the affiliate's age, and using the age distribution of CFCs in each country, we construct an "adjusted" effective tax rate not distorted by a large flow of recent investments in some countries. The corresponding coefficient estimate of 3.13 shows that the estimated tax responsiveness of capital is hardly affected.(9)

Column 4 uses a tax variable based on the average of the 1992 and

1990 effective tax rates, a measure that is less subject to **random** influences of a single year and more likely to represent the long-run equilibrium relationship sought in cross-sectional **analysis**. The estimated elasticity with respect to (1 - t) goes up somewhat and is more significant.

Host country GDP, GDP per capita, and the regional dummies, which are indicators of the relevant market size, all have significant coefficients. The human capital measure never is significant, and the only effect of including it is to reduce the significance of the GDP per capita coefficient. Therefore, we omit it from the table. Also, the interaction of the regional dummies with the tax term is only significant in the case of the EC, and those results are omitted, too.

In the final column of Table 1 the dependent variable is the number of U.S. affiliates located in the country,(10) which demonstrates another aspect of the location decisions of firms and addresses any potential reservation over the measurement of capital. The coefficient of the tax variable is 1.3, which indicates that a 1 percent decline in the cost of capital leads to a 1.3 percent increase in the number of affiliates located in the country. If the total capital response figure reported in the other columns is thought of as the product of the number of affiliates and the average amount of capital invested per affiliate, taxes can be seen to influence both elements of the total effect.

Table 2 indicates how sensitive the Table 1 aggregate results are to the exclusion of certain locations. Apart from our usual concern that the high tax responsiveness observed may be due to a few idiosyncratic countries, this approach also addresses the possible bias from including tax-haven countries where firms choose to incorporate even though their capital assets are used outside of that country. Regressions using both the 1992 effective tax rate and the 1990-92 average are given. The first two columns exclude the countries with the highest and lowest 1992 effective tax rates. The results are little different from the comparable ones in Table 1. The next two columns exclude the five locations with average effective tax rates below 7.5 percent. The tax coefficients decline, but they are significant at the 5 percent level and still substantial in size, 2.43 with 1992 effective tax rate alone, and 2.90 with the 1990-92 average. In addition, if the three locations with population less than one million are excluded, the tax coefficient is not affected.

(TABULAR DATA 2 NOT REPRODUCIBLE IN ASCII)

The regressions in the fifth and sixth columns of Table 2 exclude countries with average effective tax rates below 7.5 percent and above 40.0 percent, leaving 48 in the sample. Surprisingly, the tax responsiveness coefficients go up. The next two columns exclude the 16 locations with GDP per capita less than $1,000. The tax responsiveness coefficients are hardly affected.

The last two columns show that the results are sensitive to the inclusion of the trade regime-tax interaction term. The tax responsiveness coefficients decline to less than half their **value** in Table 1, and the coefficient based on the 1992 effective tax rate alone is significant only at the 10 percent level.(11) The tax coefficient for the 1990-92 average, however, remains significant at the 5 percent level as well as the coefficient for the inverse form of the 1992 rate used in the fourth column of Table 1. If a very basic formulation is used, in which the only explanatory variables are GDP and the tax variable, the tax coefficient is three and statistically significant at the 1 percent level. Distinguishing the trade regime becomes important when other country variables, such as GDP per capita and the regional dummies, are included.

POTENTIAL EXCLUDED VARIABLES

One issue in interpreting the tax results is whether low tax rates are correlated with other policies that promote investment, such as the provision of public goods or non-tax subsidies. On a priori grounds, the correlation between low average effective tax rates and other incentives could be either positive or negative. Greater non-tax incentives could be

associated with high tax rates if a country tries to offset a high tax rate by offering nontax incentives to foreign companies.

The 1982 Benchmark Survey of Foreign Direct Investment included a set of questions that allow us to address the issue of non-tax incentives. Companies were asked to indicate whether they had received various types of incentives (or were subject to various performance requirements). Variables based on the frequency of positive responses by country were never significant and did not affect the tax coefficients. When the percentage of companies in a country stating that they had received non-tax subsidies is regressed on the 1982 average effective tax rate, the correlation is positive although not statistically significant. (The t **value** is about 1.5.) Thus, it appears that including non-tax incentives would increase the estimated importance of the tax variable.

It might be considered useful to include an indicator of ex ante pre-tax profitability in a location, but no valid direct measure is available. One possible indicator of expected profitability is the country's rate of GDP growth in the recent past, on the grounds that corporate profits are higher in more rapidly growing economies. When the rate of growth from 1980 to 1989, as reported in United Nations statistics, was used as an independent variable, the tax coefficient tended to become slightly larger but the growth coefficient was negative.

Finally, we consider more directly the implication of omitting a wage variable, which some researchers have found to be a significant explanatory factor (Wheeler and Mody, 1992). If high-tax countries also have higher wages, then omitting wages might cause the importance of taxes that we report to be overstated. Ideally we would specify this relationship more fully and consider not only the role of wages but also of labor productivity in developing an appropriate labor cost variable. Because such information is not available, we instead regressed the average effective country tax rate on the measure of manufacturing wage rates reported by Wheeler and Mody. We found no statistically significant relationship. Also, when we included the wage variable as an independent variable to explain the amount of capital located in a country, it appeared to be collinear with GDP per capita; neither variable was significant, and the remaining coefficient estimates and their significance were not affected.

IMPLICATIONS FOR CAPITAL ALLOCATION

The empirical **analysis** has identified the distribution of MNC real capital among high and low tax countries. Can the estimated tax coefficients be interpreted as elasticities on the margin, given the increase of capital from U.S. MNCs a jurisdiction can expect if it lowers its average effective tax rate? Yes, if we assume the capital allocation structure in equation (1), in which $K_j = f(t_j, t_A, t_{US}, N, X_j)$ and there are a large number of countries, N, where an MNC can invest. Consider a country making a small cut in its tax rate so that it is just equal to the next lowest country in the tax distribution. It can expect the same investment as its neighbor now has, because the only difference between country j, which has just lowered its tax rate, and its neighbor is that country j faces a slightly lower average tax rate. That is, country j will not have competition like its former self with a tax rate just slightly above its own. But if there are many potential competitors, this effect, the change in t_A, would be insignificant. The total derivative of K_j with respect to t_j includes a dt_A/dt_j term that becomes zero as N becomes very large.

As noted earlier, the actual demand for capital function may have a more complex structure, with some groups of locations being much better substitutes than others because of geographic or factor endowment proximity. Only in the case of the EC did we find that special attention to heightened tax competitiveness within a region was warranted, and therefore, we do not pursue that distinction.

If the simple choice function applies, we can make a summary calculation of the effect of differences in foreign tax rates on the

allocation of U.S. MNC capital abroad. In fact, our use of a cross-section of countries in a single year makes it impossible to estimate the effect of a change in (t.sub.A) or (t.sub.US). Nevertheless, if the U.S. tax rate is held constant while all foreign tax rates converge on the mean (leaving (t.sub.A) unchanged), then the estimated coefficient for (t.sub.i) should give the effect of each country's shift toward the mean. Using the tax response coefficient reported in Table 1, we calculate that adjusting each tax rate to the mean host country **value** yields absolute differences equal to 37.6 percent of total investment. Because any reallocated capital is accounted twice, this figure suggests that almost 19 percent of capital is reallocated for tax considerations.

CONCLUSIONS

Host country average effective tax rates appear to have a highly significant effect on the location and investment decisions of U.S. manufacturing companies. This conclusion is based on country-level **analysis**gt; of the international operations of more than 500 U.S. companies in 60 potential locations. The results appear to be quite robust. Tax responses remain significant when tax havens or very poor countries are excluded from the sample.

Countries with more restrictive trade policies appear to attract less U.S. investment, perhaps because trade restrictions are indicators of restrictions on business in general. Countries with restrictive trade regimes are also less able to use low taxes to attract investment. Presumably this reflects the fact that much of the output that might potentially be attracted would be sold in other markets. For countries with open trade regimes, the combined tax response elasticity, based on a higher probability of choosing to locate in a country and a larger amount of capital invested there, is approximately three. This figure is not applicable to all host countries, but if current stocks of investment are used to weight responses for each trade regime, the corresponding overall elasticity is two. Thus, most U.S. MNC capital appears to be located where foreign tax changes can substantially affect the amount of investment there.

Acknowledgments

We thank Gordon Wilson and Paul Dobbins for providing us with the data base and advising on its use. Without implicating, we are grateful to Len Burman, Rachel Griffith, Bill Randolph, and two referees for helpful advice. Nothing in this paper should be construed as the views and policy of the U.S. Treasury Department.

(1) See Hines (1997) for a convenient summary of work in this area.

(2) Their approach is most closely related to firm-level studies of domestic investment behavior, where aggregate **analysis**gt; has been particularly unsuccessful due to problems of simultaneity in the determination of investment and the cost of capital. See Hassett and Hubbard (1996) for a survey of empirical, firm-level studies of domestic investment that yield short-run estimates of the response of investment to changes in the cost of capital.

(3) In a simple model without depreciation or government incentives, the cost of capital will be the after-tax rate of return, r, divided by one minus the tax rate, (1 - t), or r/(1 - t),

(4) OLS estimation assumes that the error terms from each of the country observations are independent. If the error term from investing in one location were correlated with the error term from investing in another location, the precision of the resulting estimates could be overstated. That issue cannot be addressed in the current aggregate framework for a single year. Another issue is that the tax variable may simply be a proxy for unmeasured country-specific effects. In a cross-section for a single year, this possibility cannot be addressed directly. In a follow up to the present paper, Altshuler, Grubert, and Newlon (1998) report a preliminary **analysis**gt; that looks at aggregate data on capital stocks for two different years, 1984 and 1992. Over this eight-year **interval**gt; substantial variation in tax rates within individual countries has

occurred, which warrants considering how changes in tax rates are related to changes in capital allocations. Such an approach can control for country-specific nontax factors that do not change at the same time. The magnitude and significance of the tax variable did not fall in this framework.

(5) Including a regional dummy and its interaction with the host country tax variable implies that the observed response to the host country tax rate depends upon the difference between the rate in that country and the mean for the region. Countries not included in the regional dummies are a heterogeneous group that includes South Africa, Nigeria, Israel, and Morocco. Also, see Hines (1996) for a related treatment of real capital invested by foreigners across states in the United States. He represents the competing tax in alternative locations by a weighted-average rate based on the size of business activity in each state, a measure that ignores regional effects within the United States but does vary for each state considered.

(6) A U.S. shareholder for the purpose of this definition must own 10 percent or more of the foreign company. Only concentrated holdings count. More than 75 percent of the CFCs on the 5471 file are 100 percent controlled. The average ownership level is 94 percent.

(7) Puerto Rico was not one of the potential locations in this **analysis**gt;. The U.S. operations in Puerto Rico under section 936 are incorporated in the United States and not CFCs. The tax rules governing the possessions are unique and more favorable than those governing CFCs. Since the overwhelming share of Puerto Rican output is imported into the United States, 936 corporations differ from most CFCs. Nevertheless, it would be interesting to integrate them into the present data base.

(8) We also use the firm-level data to make probit and tobit estimates of the location decisions of individual firms, and we find that they corroborate the aggregate estimates. The combined effect of a lower tax rate increasing the probability that a firm will locate in a given country and also increasing the amount of capital it chooses to locate there yields a combined elasticity of the expected amount of capital equal to about three. Firm-level **analysis**gt; for separate industries also reveals differences in tax sensitivity that conform to expected differences in mobility: the location of computer and electronics companies is highly responsive to local tax rates, while taxes appear to have no effect on the choice of location in food and drugs, areas where local brand names, regulations, and price controls are likely to have a greater influence on firm location. Finally, micro data provide an opportunity to incorporate the role of the parent's foreign tax credit position. When a dummy variable that indicates whether the parent is in an excess credit position is interacted with the host country tax rate, it has no significant effect on the firm's locational choice. In fact, there are differences across firms in their potential mobility internationally, and the firm's tax sensitivity seems to determine its excess credit position and not the reverse. For example, computer companies, which tend to be in excess limit, are much more sensitive to taxes than petroleum companies, which tend to be in excess credit.

(9) The age coefficients derived from the CFC-level **analysis** would be expected to yield much more precise estimates of age effects than simply adding the average age of CFCs as an independent variable in a location regression, because of the large variation of CFC ages within a location but relatively modest differences in average age across locations. As another attempt to control for timing and composition effects that may cause distortions in the average effective tax rate, we replaced that tax variable with the exogenously given statutory tax rate. That procedure is similar to using the statutory tax rate as an instrument for the average effective tax rate. The corresponding coefficient estimate is 1.91, significant at the 4 percent level.

(10) Hines (1996) estimates a similar inward investment equation using OLS. For an alternative approach, see Papke's (1991) maximum

likelihood estimation of Poisson model.

(11) When the regression is restricted to the 26 countries with open trade regimes, the estimated tax coefficient is 2.6, which is significant at the 5 percent level.

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Descriptors: Foreign investments--Taxation; Tax rates--Influence; International business enterprises--Taxation
Geographic Codes: 1USA United States; 0JINT International
File Segment: LRI File 150

30/9/10 (Item 10 from file: 148)
13112623 Supplier Number: 68769335 (THIS IS THE FULL TEXT)
Does Physician Specialty Affect the Survival of Elderly Patients with Myocardial Infarction?(Statistical Data Included)

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Health Services Research , 35 , 5 , 1093
Dec , 2000
Document Type: Statistical Data Included
ISSN: 0017-9124
Language: English
Record Type: Fulltext
Word Count: 7939 Line Count: 00675

Text:

Objective. To determine the effect of treatment by a cardiologist on mortality of elderly patients with acute myocardial infarction (AMI, heart attack), accounting for both measured confounding using risk-adjustment techniques and residual unmeasured confounding with instrumental variables (IV) methods.

Data Sources/Study Setting. Medical chart data and longitudinal administrative hospital records and death records were obtained for 161,558 patients aged (greater than or equal to) 65 admitted to a nonfederal acute care hospital with AMI from April 1994 to July 1995. Our principal measure of significant cardiologist treatment was whether a patient was admitted by a cardiologist. We use supplemental data to explore whether our **analysis** would differ substantially using alternative definitions of significant cardiologist treatment.

Study Design. This retrospective cohort study compared results using least squares (LS) multivariate regression with results from IV methods

that accounted for additional unmeasured patient characteristics. Primary outcomes were 30-day and one-year mortality, and secondary outcomes included treatment with medications and revascularization procedures.

Data Collection/Extraction Methods. Medical charts for the initial hospital stay of each AMI patient underwent a comprehensive abstraction, including dates of hospitalization, admitting physician, demographic characteristics, comorbid conditions, severity of clinical presentation, electrocardiographic and other diagnostic test results, contraindications to therapy, and treatments before and after AMI.

Principal Findings. Patients admitted by cardiologists had fewer comorbid conditions and less severe AMIs. These patients had a 10 percent (95 percent CI: 9.5–10.8 percent) lower absolute mortality rate at one year. After multivariate adjustment with LS regression, the adjusted mortality difference was 2 percent (95 percent CI: 1.4–2.6 percent). Using IV methods to provide additional adjustment for unmeasured differences in risk, we found an even smaller, statistically insignificant association between physician specialty and one-year mortality, relative risk (RR) 0.96 (0.88–1.04). Patients admitted by a cardiologist were also significantly more likely to have a cardiologist consultation within the first day of admission and during the initial hospital stay, and also had a significantly larger share of their physician bills for inpatient treatment from cardiologists. IV **analysis** of treatments showed that patients treated by cardiologists were more likely to undergo revascularization procedures and to receive thrombolytic therapy, aspirin, and calcium channel-blockers, but less likely to receive beta-blockers.

Conclusions. In a large population of elderly patients with AMI, we found significant treatment differences but no significant incremental mortality benefit associated with treatment by cardiologists.

Key Words. Acute myocardial infarction, mortality, cardiovascular treatment effects, instrumental variables methods

Although clinical trials have shown that the mortality from acute myocardial infarction (AMI) can be significantly reduced through the use of primary angioplasty (Gibbons, Holmes, Reeder, et al. 1993; Grines, Browne, Marco, et al. 1993; Michels and Yusuf 1995), thrombolytic therapy (Fibrinolytic Therapy Trialists' Collaborative Group 1994), aspirin (Krumholz, Radford, Ellerbeck, et al. 1995), beta-blockers (MIAMI Trial Research Group 1985; Infarct Survival Collaborative Group 1986), and angiotensin-converting enzyme inhibitors (ACE-inhibitors) (Latini, Maggioni, Flather, et al. 1995; Pfeffer, Braunwald, Moye, et al. 1992), physicians frequently fail to prescribe these therapies (Ryan, Anderson, Antman, et al. 1996; Brand et al. 1995). Since cardiologists have been shown to be more knowledgeable about the appropriate utilization of therapies to treat AMI (Ayanian, Hauptman, Guadagnoli, et al. 1994), a recommendation that cardiologists have primary treatment responsibility for all patients with AMI might improv e the quality of care and outcomes of these patients.

In fact, one study showed that patients admitted by cardiologists were 12 percent less likely to die in the first year compared to patients admitted by internists (Jollis, DeLong, Peterson, et al. 1996). A subsequent study with limited statistical power did not confirm this association (Ayanian et al. 1997). Recently, a study of California Medicare beneficiaries with AMI confirmed that patients admitted by cardiologists had a lower mortality rate than patients admitted by internists, family practitioners, or medical subspecialists (Frances, Go, Dauterman, et al. 1999). However, adjustment for patient and hospital characteristics markedly reduced the association between physician specialty and patient mortality, whereas additional adjustment for measured treatments had little effect. Frances and colleagues (1999) postulated that the remaining benefit of cardiologist care might be due to residual confounding, but they could not distinguish the possibility that cardiologists perform better at unmeasured process es of care from their presumption that cardiologists care for healthier patients. In these studies, adjusting for other

treatments received can be problematic, because the use of specific treatments may be correlated with unmeasured patient variables, just as treatment by a cardiologist may be. In the absence of a randomized controlled trial, which will likely never be performed, experts have suggested that resolving the debate over the benefits of care by a cardiologist may require better means of risk adjustment and of accounting for other beneficial treatments that are not causally related to cardiologist care (Ayanian et al. 1997).

One potential approach to removing residual selection bias is instrumental variables (IV) (Newhouse and McClellan 1998). IV methods have been used extensively in economics and have recently been used to account for unmeasured patient differences in observational medical studies (McClellan, McNeil, and Newhouse 1994). To use these methods, researchers must first identify observable variables for use as IVs that can effectively "randomize" patients into groups with different likelihoods of receiving the treatment of interest, while maintaining balance across the groups with respect to potential confounding health characteristics. For example, a prior study used the differential distance, defined as the distance from a patient's home to the nearest hospital offering angiography minus the distance from a patient's home to the nearest hospital that did not offer angiography, as an instrumental variable to separate patients into those more or less likely to receive invasive therapy for AMI. Patients with small dif ferential distances, those who lived near a hospital with angiography, had similar health characteristics to patients who lived farther away, but they had a significantly higher likelihood of receiving coronary angiography and cardiac revascularization procedures (angioplasty and bypass surgery). By using IV, the researchers were able to adjust for potential unmeasured risk factors that could not be accounted for by standard risk-adjustment methods, and thereby obtained an estimate of the health benefits of the additional or incremental use of intensive procedures that was not confounded by selection bias (McClellan, McNeil, and Newhouse 1994).

Given the inability of prior studies to determine whether cardiologists' patients with AMI actually have a lower mortality rate than patients treated by other physicians, we used both traditional risk adjustment and IV methods to evaluate the association of physician specialty and one-year mortality among 161,558 Medicare beneficiaries with AMI. Our **analysis** used a large national sample of elderly patients with a very extensive set of risk adjusters, and also assessed whether IV methods indicated substantial residual confounding. In addition, our **analysis** also explored the relationship between being admitted by a cardiologist and the intensity of treatment by cardiologists throughout the initial hospital stay. Virtually all previous studies have simply evaluated admission by a cardiologist. Thus, our study provides a significantly better opportunity to isolate the effect of cardiologist care from that of measured and unmeasured confounding variables for a nationally representative population.

METHODS

Data Sources

Our principal data were collected by the Cooperative Cardiovascular Project (CCP), a major policy initiative undertaken by the Health Care **Financing** Administration (HCFA) to improve health care quality for Medicare beneficiaries with AMI. CCP medical record abstracts for each patient include dates of hospitalization, demographic characteristics, comorbid conditions, severity of clinical presentation, electrocardiographic and other diagnostic test results, contraindications to therapy, and treatments before and after AMI (Normand et al. 1996). The reliability of the data abstraction process, which included more than 150 variables, has been demonstrated previously (Marciniak, Ellerbeck, Radford, et al. 1998). The clinical data from the CCP file were linked to longitudinal Medicare hospital discharge records, also maintained by HCFA, which identify the attending physician of each patient based on a Unique

Physician Identification Number (UPIN). The UPIN file for 1995 identifies the practice setting and self-repo rted specialty for all physicians treating Medicare patients. The discharge records also provide detailed information on intensive procedures performed, including cardiac catheterization and revascularization (angioplasty and bypass surgery). The clinical data were linked to death records from the HCFA Denominator file, which includes complete date of death information for Medicare beneficiaries. Each patient's residence was characterized as urban or rural based on its location within one of 320 metropolitan statistical areas.

Study Subjects

We identified 210,996 Medicare beneficiaries across the United States who were hospitalized with AMI between April 1994 and July 1995. The diagnosis of AMI was confirmed by chart review for each patient. The definition of AMI required either a creatine kinase--MB index (greater than or equal to) 5 percent or an elevated lactate dehydrogenase level (LDH) with LDH-1 (greater than or equal to) LDH-2; or two of the following three criteria: chest pain, creatine kinase greater than or equal to twice the normal **value**, and electrocardiogram (ECG) evidence of AMI (Ellerbeck, Jencks, Radford, et al. 1995). We excluded patients who did not have a confirmed AMI (n = 23,480); and patients who had been transferred from another acute care hospital (14,137), since we lacked information regarding their presenting clinical characteristics. Patients whose records lacked information regarding their treating physician (63) or the geographical location of their home (15,803) were also excluded because our analyses depended on the se variables. Only the first admission of a patient was included in the **analysis**. A total of 161,558 patients were evaluated.

To evaluate the possibility that patients treated by noncardiologists might have achieved a differential benefit from transfer to a second acute care hospital, we repeated all analyses excluding patients who were transferred out of the hospital within three days of admission. When we evaluated the remaining 148,325 patients, the results were virtually unchanged.

Treatment Variables

Admitting physicians were categorized based on their self-reported specialty in the UPIN file, which has been shown to have a high correlation with board certification status (Jollis, DeLong, Peterson, et al. 1996; Ayanian et al. 1997). Physicians who reported their primary or secondary specialty to be cardiology were defined as "cardiologists." All other physicians were classified as "noncardiologists."

To determine whether admitting physician specialty was correlated with intensity of treatment by cardiologists throughout a patient's initial hospital stay, we conducted a supplemental **analysis** of all physician billing records during the hospital stay from the Medicare Physician/Supplier (Part B) File for an approximately 5 percent **random** sample of Medicare beneficiaries admitted to the hospital with a primary diagnosis of new AMI during the time period of our **analysis** and for whom complete billing data could be obtained. We used these data to construct other patient variables, in addition to admission by a cardiologist, to describe the intensity of cardiologist treatment more completely. The additional cardiologist treatment variables were: whether or not the patient had at least one cardiology consultation during the first 24 hours of admission; whether the patient had at least one cardiology consultation at some time during the initial admission; the share of total Medicare physician payments during the in itial hospital stay made to cardiologists; and the percent of all physician expenditures allocated to cardiologists. We defined patients as being in the "large cardiology share" (30 percent of all patients) if the proportion of all physician payments made to cardiologists exceeded 39 percent. We used this 5 percent sample to explore the relationship between being admitted by a cardiologist and these other aspects of cardiology care.

Hospitals were categorized along two dimensions to allow us to

assess the impact of more intensive cardiologist care as well as whether other treatment and outcome effects are correlated with but not causally related to treatment by a cardiologist. First, we defined a hospital as a "cardiologist hospital" if cardiologists treated (greater than)50 percent of CCP patients admitted with AMI to that hospital. Second, we defined hospitals as "high volume" if they treated more than 50 Medicare patients with AMI in the CCP (Newhouse and McClellan 1998). Hospitals were also described based on their capacity to provide coronary angiography and revascularization.

Outcome Variables

Our primary outcomes were 30-day and one-year patient mortality rates by physician specialty. Secondary outcomes included treatment decisions that we hypothesized may be causally related to treatment by a cardiologist: the use of medical treatments and cardiac procedures. Medical treatments included in-hospital treatment with thrombolytic therapy, aspirin, beta-blockers, ACE-inhibitors, and intravenous nitroglycerin; and discharge treatment with aspirin, beta-blockers, ACE-inhibitors, and calcium channel-blockers. Procedure outcomes included the use of coronary angiography, percutaneous transluminal coronary angioplasty (PTCA), and coronary artery bypass graft surgery (CABG) during hospitalization.

Missing Data

Missing data were handled with an imputation process. Missing data for an individual patient nearly always occurred in clusters. For example, EGG lead results or chemistry values were nearly always absent collectively rather than individually. Because the values of these variables do not vary independently, we imputed values by cluster using a hotdeck procedure based on approximately 50 demographic and clinical variables that were almost always present (Meng 1997; Fitzmaurice and Laird 1997; McClellan and Noguchi 1998). To evaluate the effect of imputed data, we repeated all analyses without the imputed variables and verified that the results did not change significantly.

Analytic Approach

To evaluate the effect of treatment by a cardiologist, we initially compared the populations of patients treated by cardiologists and noncardiologists. Pairwise comparisons between groups were made using chi-square tests for dichotomous data and the student's t-test for continuous data. Because of our very large sample size, quantitatively small differences in characteristics that had no substantial effect on patient outcomes were often statistically significant.

We then employed robust (heteroscedasticity-consistent) least-squares (LS) multivariate linear regression to risk adjust for measured differences between the two populations. We first adjusted for demographic and geographic variables only (see Appendix for list of covariate categories). We then adjusted for comorbid illnesses and measures of disease severity. Our final models also included the effect of admission to a hospital that treated a high volume of AMI patients. We did not include patient receipt of medications or procedures, as these may be causally related to treatment by a cardiologist and may also be subject to confounding. The absolute 30-day and one-year mortality rates associated with treatment by cardiologists versus treatment by noncardiologists were calculated in each **analysis**.

Because LS risk-adjustment methods can only adjust for measured patient characteristics, we used IV methods to adjust for potential unmeasured confounding in the patients treated by cardiologists and by high-volume hospitals. IV **analysis** requires a variable that is not correlated with patient characteristics (e.g., comorbidity or severity of illness) that directly affect outcomes (e.g., mortality), but that is associated with the probability of the patient receiving the treatment of interest. We hypothesized that the location of a patient's residence would independently predict the likelihood of being treated by a cardiologist. We grouped patients geographically based on their differential distance to a cardiologist hospital, a hospital where over half of CCP patients were

treated by a cardiologist. Our differential distance was defined as the distance from a patient's home to the nearest cardiologist hospital minus the distance from a patient's home to a noncardiologist hospital. Patients with smaller diffe rential distances are thus closer to hospitals where cardiologists treat a majority of AMI patients. Approximate geographic locations of patient homes and hospitals were estimated using the geographic centroid of their respective ZIP codes. We then used an algorithm to estimate the distance between patient and hospital ZIP codes and to identify the minimum distance to each type of hospital for each patient.

To evaluate the validity of our instrumental variable, we stratified the entire cohort into two groups based on their differential distance to a cardiologist hospital. We used the median differential distance (6.6 miles) to separate the population approximately in half. This initial comparison validated our primary assumption that differential distance to a cardiologist hospital was not associated with the health status of the patients but was a strong predictor of treatment by a cardiologist.

To utilize the full range of the differential difference variation, we applied more general IV estimation techniques by stratifying the population into a larger number of groups. Urban residents were categorized into groups based on differential distances of less than -2.8 miles, -2.8 to 0.00, 0.01 to 2.20, 2.21 to 4.70, 4.71 to 9.80, 9.81 to 20.8, and greater than 20.8 miles; rural residents were categorized by differential distances of less than 9.7 miles, 9.8 to 22.6, 22.7 to 33.4, 33.5 to 48.0, and greater than 48 miles. Urban and rural residents were categorized differently since larger differential distances were needed to establish equal groups of rural residents. Separating the population into these cells extended the two-group IV comparison across a larger number of differential distance groups that did not differ substantially in their measured characteristics. We included variables for patient demographic, comorbidity, and severity of illness information in our multivariate IV models (Rubin 1997).

Because we found that cardiologists and cardiology hospitals tended to be associated with larger, more experienced, and more intensive facilities, we also repeated our IV models including the effect of treatment by a high-volume hospital (independent of treatment by a cardiologist). Our goal was to remove at least some of the confounding caused by potentially beneficial treatments that were associated with but not causally related to greater likelihood of treatment by a cardiologist, in order to obtain the least confounded estimate possible of the mortality rate difference by physician specialty. Comparisons between cardiologists and noncardiologists are primarily expressed as adjusted percentage-point differences in outcomes; for certain examples, these are converted to relative risks (SAS Institute 1996).

Utilization of Treatments and Procedures

To determine whether there are differences in practice patterns between cardiologists and noncardiologists, we compared their respective utilization of medications and therapies. We used IV models that adjusted for both hospital volume and detailed patient characteristics to remove potential biases in our estimates of the effect of more intensive cardiologist care on use of medications and cardiac procedures.

RESULTS

Characteristics of Patients Treated by Cardiologists and Noncardiologists

Medicare patients admitted by cardiologists (38 percent) were younger and more likely to be white and male than patients treated by other physicians (Table 1). These patients were less likely to have chronic illnesses, such as diabetes mellitus, congestive heart failure, cerebrovascular disease, chronic obstructive pulmonary disease, and dementia but were more likely to have had prior angina, PTCA, and CABG surgery. Patients with a prior MI were slightly less likely to be treated by cardiologists. Severity of illness measures generally indicated that

patients treated by cardiologists were less critically ill than those treated by other physicians. Cardiologists' patients were more likely to receive early medical attention after developing symptoms, have normal vital signs and a low Killip class, and be verbally oriented compared with noncardiologists' patients.

We also found differences in hospital characteristics between patients treated by cardiologists and those treated by other physicians. Patients treated by cardiologists were more likely to be admitted to hospitals that cared for a higher volume of elderly AMI patients and that provided coronary angiography and revascularization.

Mortality Rates Using LS Method

Patients treated by cardiologists had lower unadjusted 30-day mortality (RR = 0.77; 95 percent CI: 0.75--0.79) and one-year mortality (RR = 0.73; 95 percent CI:0.72--0.75) compared with patients treated by other physicians (Table 2). Adjusting for demographic and geographic characteristics reduced the one-year mortality difference attributable to cardiologists by over 30 percent (RR = 0.81; 95 percent CI: 0.80--0.83). Further adjustment for patient comorbidity and severity of illness markedly reduced, but did not eliminate, the attributable difference in one-year mortality associated with treatment by a cardiologist (RR = 0.94; 95 percent CI: 0.93-0.96). Thus, adjusting for measured selection bias decreased the mortality benefit associated with cardiologist treatment by over 75 percent.

Preliminary IV Comparisons Using Stratification by Differential Distances

To test the hypothesis that the differential distance to a cardiologist hospital is not associated with patient comorbidity or severity of illness characteristics, we stratified our population into two groups based on differential distance less than or greater than -6.6 miles (Table 3). In contrast to Table 1, the two groups were nearly identical with respect to most of the measured characteristics that predict mortality. Although rural location and race are not equally distributed in the two groups, we adjusted for these variables in our multivariate models. The effective randomization in terms of similarity of measured characteristics remained when the cohort was divided into 12 groups of equal size based on differential distances.

Despite their similar characteristics, the two groups showed important differences with respect to their treatment (Table 3). Patients with differential distance less than 6.6 miles were more likely to be treated in a high-volume hospital, a catheterization hospital, or a revascularization hospital, and they were 40 percent more likely to be treated by a cardiologist.

Table 4 presents evidence on the relationship between the widely applied definition of significant treatment by a cardiologist, based on whether the patient was admitted by a cardiologist, and several reasonable alternative definitions. Because these alternative definitions required complete physician billing data that we were only able to obtain for approximately 5 percent of new AMI patients admitted to the hospitals during the time period of our **analysis**, the sample sizes for this table are much smaller. Table 4 shows that, regardless of the definition of cardiologist treatment used, our IV approach distinguishes patient groups treated more and less intensively by cardiologists.

Mortality Rates Using IV Methods

In our most complete adjustment for observed and unobserved differences in patient characteristics using detailed risk adjustment plus the multivariate IV method, treatment by a cardiologist was no longer associated with significantly lower mortality rates at 30 days or one year (Table 5). Compared to the LS results in Table 2, the IV estimates of the cardiologist effect on 30-day and one-year mortality remain small, and the one-year effect is even closer to 0. The confidence **intervals** for this estimate are considerably wider; we discuss the causes and implications of the wider confidence **interval** in the next

section. In contrast to the insignificant effect for treatment by a cardiologist, admission to a hospital treating a high volume of AMI patients remained associated with a statistically significant 2 percent mortality benefit. As in our LS models (Table 2), accounting for the fact that intensive treatment by cardiologists is correlated with treatment by a high-volume hospital significantly reduces the ap parent effect of cardiologist treatment.

Mortality Rates Using Fewer Predictor Variables

To test the impact of the instrumental variable on risk adjustment with a more limited number of predictor variables, we repeated our analyses using only the predictors that Jollis, DeLong, Peterson, et al. (1996) used in their study (see Appendix). Using LS **analysis**, we found a point estimate for the relative risk associated with treatment by a cardiologist, 0.86 (95 percent CI: 0.85-0.88), that was similar to that reported by jollis, DeLong, Peterson, et al. (1996). However, when we utilized the IV **analysis** to adjust for unmeasured confounding, the estimate for the relative risk was 0.96 (95 percent CI: 0.88-1.04). Thus, detailed covariate adjustment had a substantial effect on our LS estimates but essentially no effect on our IV estimates.

Utilization of Medications and Procedures

Although we observed no significant benefit in mortality associated with treatment by cardiologists, cardiologists were more likely to utilize the most proven medications. After complete adjustment for measured and unmeasured confounding variables, cardiologists were more likely to utilize thrombolytic therapy, aspirin, intravenous nitroglycerin, and smoking cessation counseling (Table 6). However, they were also more likely to prescribe calcium channel-blockers at discharge and less likely to prescribe beta-blockers. We found no significant differences in the use of ACE-inhibitors by physician specialty. Patients treated by cardiologists had utilization rates for coronary angiography and revascularization (PTCA or CABG) 28 percent and 19 percent higher than patients of noncardiologists. These differences increased to 33 percent and 29 percent after IV adjustment.

DISCUSSION

As previously demonstrated by other studies, we found that cardiologists treat AMI patients who generally have better survival prospects than patients treated by other physicians (Jollis, DeLong, Peterson, et al. 1996; Ayanian et al. 1997; Frances, Go, Dauterman, et al, 1999). Compared with noncardiologist patients, patients admitted by cardiologists were more likely to have demographic characteristics associated with lower mortality from AMI, including younger age, male sex, and white race (Normand et al. 1996; Vaccarino et al. 1995). In addition, patients treated by cardiologists were more likely to be able to walk independently and were less likely to have a comorbid illness associated with worse outcomes after AMI, including diabetes (Miettinen, Lehto, Salomaa, et al. 1998), hypertension (Gustafsson, Kober, Torp-Pedersen, et al. 1998), congestive heart failure (Normand et al. 1996), and depression (Barefoot, Helms, Mark, et al. 1996). Finally, consistent with prior studies, patients admitted by cardiologi sts appeared to have less severe AMIs, as assessed by Killip class and hemodynamic status (Donohoe 1998).

Although the outcomes of patients treated by cardiologists clearly differ from those of patients treated by other physicians, the two large prior studies that evaluated the association of physician specialty and patient mortality from AMI found that measurable selection bias explained only part of the observed benefit from cardiologist care (Jollis, DeLong, Peterson, et al. 1996; Frances, Go, Dauterman, et al. 1999). Although treatment differences between cardiologists and other physicians could account for the residual differences in patient mortality by physician specialty, one study found that differences in measured processes of care could account for only a small portion of the lower mortality rate associated with treatment by cardiologists (Frances, Go, Dauterman, et al. 1999). Traditional methods of risk adjustment cannot determine whether the

mortality reduction associated with cardiologist care results from residual unmeasured differences in patient characteristics or in physician treatment decision s.

Our **analysis**amp; used both extensive risk-adjustment methods and IV methods to assess selection bias. Our risk-adjustment methods differed from previous studies in our use of a much larger sample size and a much more extensive set of risk adjusters, as well as controls for hospital volume, which we hypothesized would diminish the amount of unmeasured confounding. By estimating our risk-adjustment models, including only predictors that Jollis, DeLong, Peterson, et al. (1996) used in their study (see Appendix), we were able to demonstrate more fully the significance of unmeasured confounding. We found a point estimate for the relative risk of one-year mortality associated with treatment by a cardiologist, 0.86 (95 percent CI: 0.85-0.88), that was similar to that reported by Jollis, DeLong, Peterson, et al. (1996). Our more detailed LS model significantly reduced the apparent association between cardiologist treatment and mortality to a relative risk of 0.94 (CI: 0.93-0.96).

To determine whether our risk adjustment results still suffered from significant residual confounding despite our very detailed multivariate model, we used IV methods as well. We postulated that patients who live relatively close to a hospital where most patients are treated by cardiologists would be similar to patients who live farther from such a hospital. This assumption is intuitive since people are unlikely to choose their residence based on whether AMI patients are primarily treated by cardiologists at hospitals that are relatively close by. We demonstrated that the differential distance to a hospital where most patients are treated by cardiologists, our instrumental variable, allowed us to construct groups that did not differ meaningfully in measured patient characteristics that predict mortality. We also found that patients who live relatively near a hospital where cardiologists care for most MI patients were 40 percent more likely to be treated by a cardiologist. Since the differential distance to a cardiologist hospital effectively randomized patients by creating groups with very similar health characteristics that differed in their likelihood of being treated by a cardiologist, it satisfied the required prerequisites of an instrumental variable.

Our IV **analysis**amp; showed that the slightly lower one-year mortality rate apparent in the LS models after accounting fully for observable patient differences and for treatment at high-volume centers may still overstate the effect of cardiologist care. Because the fully risk-adjusted estimate of the cardiologist effect was small in absolute magnitude, the IV methods had only a quantitatively modest further effect, even though the point estimate was 35 percent smaller (relative risk of 0.96 compared to 0.94). The IV-estimated effect was virtually identical (relative risk of 0.96) in models that included only a more limited set of risk adjusters, as in the Jollis, DeLong, Peterson, et al. (1996) study, confirming the finding in Table 3 that the IV **analysis**amp; does not appear to be confounded by differences in case mix. However, the confidence **intervals**amp; of our IV estimates were considerably wider than the confidence **intervals**amp; of the LS estimates. This is a general feature of IV analyses: because the estimates are base d on a much more limited (albeit "cleaner") source of variation in treatment compared to actual (but potentially biased) treatment choice, the residual variance tends to be considerably wider than in LS models. While the wider **intervals**amp; imply that our fully adjusted LS estimate and all of our IV estimates are not significantly different, the IV analyses consistently suggest that a favorable residual bias exists in the very precise LS estimate of the cardiologist effect. Since our sample essentially was the entire population of elderly AMI patients admitted to the participating hospitals during the study period, we conclude that, at least for elderly AMI patients in the time period we studied, the long-term mortality benefit of more intensive treatment by a cardiologist was extremely close to 0. Our results suggest that an incremental reduction

in the use of cardiologists, as in our "low-cardiologist" hospitals, would have no substantial adverse mortality consequences.

Although greater treatment by a cardiologist was not associated with substantially lower one-year mortality, important differences were observed in the utilization of medications and procedures. As prior studies have also shown, patients treated by cardiologists were more likely to receive thrombolytic therapy, primary angioplasty, aspirin within a day of admission, and revascularization with angioplasty or bypass surgery during hospitalization (Jollis, DeLong, Peterson, et al. 1996; Ayanian et al. 1997; Frances, Go, Dauterman, et al. 1999; Borowsky, Kravitz, Laouri, et al. 1995). In contrast to a prior study (Jollis, DeLong, Peterson, et al. 1996), however, we found that noncardiologists were more likely to use beta-blockers both in the hospital and at discharge than cardiologists after adjustment for selection bias. A recent study that evaluated CCP patients who were "ideal" candidates for beta-blockers found, after adjusting for measured variables, that cardiologists were more likely to prescribe beta-blo ckers (Krumholz, Radford, Wang, et al. 1998). Using analyses that adjust for both measured and unmeasured forms of patient and hospital selection bias and that accounted for other hospital factors such as volume that were also associated with cardiologist treatment, we found that patients treated by noncardiologists were actually more likely to receive beta-blockers. While this particular finding regarding beta-blocker use might be anomalous, we note that it appears only in our fully adjusted IV model that includes both very detailed covariate adjustment and careful controls for treatment by high-volume hospitals. Thus, it is possible that the difference between our study and other recent studies can be explained by the following. (1) We included more extensive comorbidity controls. Because less severely ill patients are more likely to be treated with beta-blockers, this difference in methods will reduce any apparent cardiologist benefit. (2) We accounted for the correlation between treatment by a cardiologis t and treatment by a high-volume hospital in a way that did not introduce new selection bias. In our study, higher-volume hospitals treated somewhat more severely ill patients and were more likely to adopt current standards of best practice, so that this difference in methods will also reduce any apparent cardiologist benefit. This finding highlights the need for use of adjustment methods in observational studies that go beyond accounting for measured differences in patient severity and use care to account for other, correlated treatments that might also be subject to selection bias. However, efforts to improve quality of care might be more profitably directed to areas other than cardiologist-noncardiologist comparisons. Not only do the incremental health benefits of greater cardiologist treatment appear quite modest, more importantly, regardless of physician specialty, fewer than half of patients received beta-blocker therapy in the hospital or at discharge regardless of physician specialty.

The primary strength of our study is the utilization of a comprehensive risk-adjustment model and IV techniques to control for measured and unmeasured selection bias. Prior studies have been unable to distinguish treatment effect attributable to specialty care from residual selection bias. Our **analysis** was able to determine the relative impact of patient and hospital characteristics on the mortality difference observed between patients treated by cardiologists and noncardiologists. In addition, in contrast to prior studies that focused on specific geographic regions (Ayanian et al. 1997), we analyzed the entire population of Medicare patients with MI covered by fee-for-service health insurance during a 16-month period, making this a true national study.

Our study has several limitations. First, much as we tried to overcome all of the inherent limitations of the data, our **analysis** was observational and relied on the accuracy of the data abstraction process of the CCP. Only a well-executed clinical trial randomizing patients to receive treatment with either cardiologists or noncardiologists can definitively determine whether and how physician

specialty affects patient outcomes. Such a study will likely never be performed for a representative national sample of Medicare AMI patients, so evidence on this question using the best possible techniques to account for residual biases is important on a practical level. Moreover, even an "ideal" trial would not directly answer policy questions about the health consequences of incremental increases or reductions in the use of cardiologists in providing acute MI care. Our incremental IV **analysis** that compares similar populations with more or less access to cardiologists seems best-suited to such questions.

Second, we used self-reported data reporting physician specialty, so we may have misclassified physicians and obscured a possible benefit associated with cardiologist care; however, self-reported and actual physician specialty are highly correlated (Ayanian et al. 1997; Jollis, DeLong, Peterson, et al. 1996). Third, our **analysis** focused on comparing patients admitted by a cardiologist to those admitted by other physicians as our principal measure of the intensity of cardiologist care. Although our **analysis** of billing data for a subset of our patient population indicated that this measure of cardiologist use is highly correlated with a broad range of other measures of cardiologist use, further studies should address in more detail whether cardiology consultation and other particular aspects of cardiologist care have differential effects on mortality for patients with AMI. In particular, our results suggest that more limited cardiology consultations are likely to have virtually no long-term mortality consequen ces. Fourth, we lack information on the physicians treating patients who were transferred out to a second acute care facility; nonetheless, when these patients were excluded, the results remained unchanged. Finally, a one-year follow-up time may have been too short for all the benefits of cardiologists' increased utilization of revascularization procedures to emerge. However, after one year, over one-third of our elderly cohort had expired, and we found no trend over time toward increasing benefit associated with cardiologist treatment.

In conclusion, we found that patients with AMI who were treated primarily by cardiologists did not have substantially lower mortality than patients who relied more extensively on other types of physicians for treatment. This is true even though greater reliance on cardiologists led to better adherence to best practices in many dimensions, and especially to more use of intensive and costly cardiac procedures. The larger mortality differences previously reported between patients treated by cardiologists and noncardiologists were attributable in large part to patient and hospital characteristics. For outcome studies with extensive selection problems, such as the differences in the characteristics of patients treated by physicians of different specialties, IV methods combined with risk-adjustment methods can be a powerful tool for eliminating confounding.

We gratefully acknowledge **financial** support from the Health Care **Financing** Administration and the National Institute on Aging. We thank the editor and two anonymous referees for helpful comments.

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Product/Industry Names: 8000 HEALTH SERVICES
NAICS Codes: 62 Health Care and Social Assistance
File Segment: TI File 148

30/9/11 (Item 11 from file: 16)
10041432 Supplier Number: 69676629

Corporate Environmental Initiatives and Anticipated Firm Performance: The Differential Effects of Process-Driven Versus Product-Driven Greening Initiatives.(Brief Article)

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Journal of Management , v 26 , n 6 , p 1199
Nov-Dec , 2000
ISSN: ISSN: 0149-2063
Language: English Record Type: Fulltext
Article Type: Brief Article
Document Type: Magazine/Journal; Refereed ; Trade
Word Count: 8513

Text:

We investigate the influence of environmental initiatives on firms' anticipated economic performance using an event study methodology. Framing our arguments within an organizational reputation framework, we propose that, due to potential positive effects of these initiatives on firm performance (through increases in reputation), shareholders will react positively to announced environmental initiatives. Contrary to our hypothesis, we found no overall effect of announced environmental initiatives on stock returns. However, our findings indicate that reactions to product-driven initiatives are significantly different than reactions to process-driven ones. (C) 2000 Elsevier Science Inc. All rights reserved.

The impact of organizations on the natural environment has received much attention in both the popular press and academic literature in recent years. Mounting pressure from stakeholder groups has led the top executives of many firms to implement corporate environmental initiatives. The environment is now given a much higher priority in business decisions, and managers have new incentives to seize the initiative (Thomas, 1992). As evidence of the emphasis that firms place on environmental issues, over 97% of companies responding to a recent survey indicated that they have environmental strategies in place (Stead & Stead, 1995).

Although many organizations have undertaken more environmentally sensitive activities, the performance effects of corporate environmental initiatives are still somewhat uncertain (White, 1992). Environmental issues offer opportunities for growth, but they also place constraints on behavior (Shrivastava, 1995a). Environmental initiatives may provide

opportunities for organizations to build long term strategies that reduce costs, decrease liability exposure, increase efficiency, enhance stakeholder relations, and improve profitability (Dechant & Altman, 1994; Forte & Lamont, 1998; Greeno & Robinson, 1992; Porter & van der Linde, 1995; Saunders & McGovern, 1993; White, 1995). In addition, an enhanced public image, increased organizational innovation, and improved investor and employee relations may spur higher performance. However, the costs of reducing environmental impact may overshadow the resulting benefits, and organizational performance may actually decline (Walley & Whitehead, 1994; Williams, Medhurst, & Drew, 1993).

The purpose of this study is to empirically examine this issue by testing the potential influence of environmental initiatives on investors' perceptions of organizational performance. Using an event study methodology, we examine the anticipated firm performance implications of announced environmental initiatives. However, it is likely that not all environmental initiatives have the same perceived effect. Therefore, we identify and discuss two generic environmental initiatives: (1) those designed to improve organizational processes and (2) those concerned with improving the firm's products. To provide for a richer understanding of the anticipated performance effects of corporate environmental initiatives, we first examine greening announcements in general, and then we take a more finegrained approach by examining differential effects of process-driven versus product-driven greening initiatives.

Organizational Environmentalism and Firm Outcomes

Several empirical examinations have studied the performance implications of environmental management in recent years, and most of these have used event study techniques. One of the earliest examinations of investors' reactions to public announcements of corporate environmental management was conducted by Shane and Spicer (1983). They tested the effect on share price of information about firms' pollution control performance and compliance costs. Their sample consisted of 72 firms in four **historically** "dirty" industries (pulp and paper, petroleum, steel, and electrical utilities). Using data disclosed by the Council on Economic Priorities (CEP), they found that announcements of superior pollution control performance were related to increases in shareholder wealth. Conversely, the share price of firms with poor pollution control performance dropped significantly on the day of the (negative) announcement. Due to the nature of stock market-based event studies, the observed change in share price that results from announced environmental activities is assumed to reflect the market's perception of the **financial** impact of that activity (McWilliams & Siegel, 1997). (1) Therefore, the results of Shane and Spicer's (1983) study suggest that firms that improve their environmental performance also improve perceptions of their future economic performance.

Stevens (1984) also examined the potential influence of corporate environmental performance on shareholder wealth. Like Shane and Spicer (1983), his sample consisted of CEP data on 58 firms in the same four industries. He found that returns to shareholders of firms with high pollution control costs were consistently lower than those for firms with low pollution control costs. Hamilton (1995) examined shareholder reactions to environmental announcements made in the United States Environmental Protection Agency's Toxics Release Inventory (TRI). He, too, found a significant, negative stock market reaction to unfavorable environmental announcements. Another event study of interest was conducted by Klassen and McLaughlin (1996). Their findings indicate that environmental awards result in significant positive share price changes, and that those changes are even more positive for **historically** "clean" industries.

Basing their discussion on the resource-based view of the firm, Russo and Fouts (1997) also proposed that superior environmental performance leads to superior economic performance. However, their methods differ significantly from previous investigations of the subject. Departing from event study techniques, they examine the relationship between

environmental performance and economic performance using multiple regression. Consistent with most previous research, their independent variable consisted of environmental classifications provided by a third party, and their findings revealed that environmental performance had a positive effect on economic performance. Finally, in a similar study, Hart and Ahuja (1994), again using third party data, found that emissions reductions by mining and manufacturing firms lead to significant improvements in firms' bottom lines.

From this review of the literature, it is clear that environmental performance and economic performance are not mutually exclusive. Both event studies and regression analyses have provided support for a positive relationship between the two. However, the bulk of previous work on the subject has relied on third-party (e.g., CEP or EPA) assessments of firms' pollution control performance as a measure of environmental performance in general. Little research has been conducted on the relationship between perceived economic performance and a broader variety of environmental initiatives using a sample consisting entirely of voluntary public disclosures by individual firms. Stories of this nature generally start out as a press release from the company. Although they most often appear in a third-party source, they are generally initiated by the company itself, rather than by an outside group. As a result, the announcement of these initiatives may serve as an important signal to shareholders about an organization's c urrent and future intended environmental performance. Whether the perceived performance implications of a wide range of environmental initiatives will be regarded by the investment community in the same way as pollution control performance is an important empirical question that should be addressed. Therefore, although the primary focus of this article is on examining the perceived differential performance implications of different types of environmental initiatives, we also test the direct relationship between environmental initiatives and perceptions of economic performance using self-disclosed, environmentally positive, public announcements.

Consistent with prior research, we propose that shareholders will react favorably to announcements of corporate environmental initiatives. Fombrun and Shanley (1990) found that both economic and noneconomic signals about firms emanating from the press, the firms themselves, the government, and others play an important role in shaping public opinion about a firm's reputation. More specifically, they found that firms' demonstrations of social concern (among other things) had an important effect on firm reputation. This firm reputation framework provides a foundation for the study of shareholder reactions to corporate environmental initiatives. Firms' public disclosures of their environmental enhancements likely serve an important reputation building function, because these are demonstrations of firms' social concern. As noted by Fombrun and Shanley, firms achieving higher levels of reputation performance will likely find it easier to "charge premium prices (Klein & Leffler, 1981; Milgrom & Roberts, 1986b), att ract better applicants (Stigler, 1962), enhance their access to capital markets (Beatty & Ritter, 1986), and attract investors (Milgrom & Roberts, 1986a)" (1990: 233). In other words, firms with superior reputations should achieve higher levels of performance, resulting in higher stock prices. Thus, to the extent that announcements of environmental initiatives enhance a firm's reputation, the firm's share price should increase.

H1: Announcements of environmental initiatives will lead to increases in anticipated firm performance.

Differential Effects of Type of Environmental Initiative

Although several studies have investigated the effect of environmental performance on anticipated economic performance, none have examined the differential effects of different types of environmental initiatives. On the contrary, most research has focused primarily on a single type of environmental announcement and its effects on shareholder wealth. Although these studies have enhanced our understanding of this

important issue, a more fine-grained **analysis** is needed to help us draw more precise conclusions about the anticipated performance implications of different environmental initiatives (Klassen & McLaughlin, 1996).

To allow for a more fundamental understanding of this relationship, we propose that different types of environmental initiatives have unique implications for firm reputation and, therefore, for shareholders' perceptions of future firm performance. More specifically, investors' perceptions of the long run economic benefits of environmental initiatives may be dependent on the initiative's focus on enhancing the firm's production processes versus reducing the environmental impact of the firm's products or services. Therefore, we propose two generic types of environmental initiatives: process-driven initiatives and product-driven ones. Both types are designed to reduce environmental impact. However, each implies a different method of doing so and should have a unique effect on investors' perceptions of future firm performance.

Process-driven Environmental Initiatives. The first type of environmental initiative is concerned with minimizing the environmental impact of a firm's processes, and may occur in several ways. One way firms pursue process-driven environmental initiatives is by using recycled or environmentally friendly inputs to production. Examples are Mobil's use of less harmful raw materials in foam production and Coca-Cola's decision to expand its use of recycled bottles. A second way that firms may pursue process-driven environmental initiatives is through redesigning their production and/or delivery systems. Conoco's increased use of safer, double-hulled oil tankers is one example. Third, process-driven greening initiatives may be embodied in waste reduction strategies. For example, between 1975 and 1990, Minnesota Mining and Manufacturing (3M) changed its processes to reduce harmful byproducts. This saved the company over $500 million in hazardous materials disposal costs and related expenditures (Hart & Ahuja, 1994). Thus, process-driven initiatives include changes to organizational processes, as well as changes to the materials used in production. Process-driven environmental initiatives primarily impact a firm's bottom line through cost reductions (Biddle, 1993). These initiatives may allow organizations to reduce their costs by using inputs more efficiently, reducing the use of hazardous materials, avoiding accidents and the accompanying litigation and cleanup, and eliminating unnecessary steps in production (Hart, 1995; Porter & van der Linde, 1995; Stead & Stead, 1992, 1995).

The potential reputation effects of process-driven environmental initiatives are likely to be low. In making a determination of the firm's reputation, stakeholders use the information that is available to them about the firm's activities (Fombrun & Shanley, 1990). However, many stakeholder groups will be unaware of the firm's process-driven changes, because information about such changes is generally not widely disseminated. Without considerable media attention or marketing efforts on the part of the firm, many process changes that firms make are unlikely to be included in the public's assessment. This is primarily a result of the fact that process changes are generally internal to the firm and are, therefore, less visible to all publics. As a consequence, the potential reputation-enhancing effects of process-driven greening are low; therefore, we expect shareholders to react less favorably to this type of environmental initiative.

Product-driven Environmental Initiatives. The second type of generic environmental initiative is product-driven and occurs in two ways: (1) when firms create new types of environmentally sound goods or services, or (2) when they reduce the environmental impact of their existing goods or services. There are many recent examples of product-driven greening, including Kodak's introduction of a recyclable camera, Procter & Gamble's many packaging-reduction initiatives, and Toyota's completely redesigned automobile that saves gasoline by combining electric and internal combustion engines (Arnst, Reed, McWilliams, & Weimer, 1997).

This type of initiative may have an important effect on a firm's revenues by making the firm's products unique in the eyes of the consumer (Stead & Stead, 1995). By providing more environmentally sound products or services, there are spillover effects that enhance the firm's reputation, thus increasing demand for the firm's other offerings (Saunders & McGovern, 1993). (2)

The potential reputation-enhancing ability of product-driven environmental initiatives is higher than that of process-driven ones. By their very nature, the introduction of new products or major changes to existing ones are relatively high-profile events (when compared with changes in organizational processes). Because of organizations' efforts to successfully market the new and/or improved products or services, a wide variety of stakeholder groups are made aware of product-driven environmental initiatives. This increased media visibility, combined with the firm's demonstration of its social concern, should have a significant impact on firm reputation (Fombrun & Shanley, 1990). In anticipation of the increase in performance associated with this, shareholders will react positively. By comparison, the often-obscure changes in organizational processes will have relatively less of an impact on firm reputation and shareholder wealth. Thus, we propose that investors will react more favorably to product-driven envi ronmental initiatives.

H2: Announcements of product-driven environmental initiatives will have a more positive impact on anticipated firm performance than will announcements of process-driven initiatives.

Research Methods

Sample

Our unit of **analysis** is the environmental announcement/event, and our sample comes from announcements published in the Wall Street Journal over the period 1983 through 1996. To screen for potentially confounding events, announcements were excluded from the sample if any other public announcement was made about the firm in question during the previous two trading days or on the day of the environmental announcement itself (see McWilliams & Siegel, 1997). Since all relevant information about a firm is fully incorporated into its share price within minutes of its disclosure, this "window" is likely sufficient. Also excluded were announcements about firms that were privately held (due to data availability issues) or for businesses that were divisions of other firms. This screening left a final sample of 71 announcements of corporate environmental initiatives. Of these, 39 were process-driven and 32 were product-driven. Unlike many prior investigations of the environmental performance-economic performance link, t he firms in our sample come from a variety of both manufacturing and service industries. Overall, sixteen different two-digit SIC code industries were represented.

Measures

Environmental initiatives. Corporate environmental initiatives were defined as any organizational effort designed to reduce the impact of the firm's goods/services or processes on the environment. They were identified by searching the Wall Street Journal Printed Index. Some key words searched for were "environment," "environmental," "greening," and "waste reduction."

Anticipated firm performance. We assessed anticipated firm performance using stock returns of the common stock for the firms in our sample. Our stock price data come from the CRSP tapes (Center for Research in Security Prices from the University of Chicago). Our assumption is that stock returns reflect the market's perception of the outcomes of firm strategy. The semi-strong form of the Efficient Markets Hypothesis (see Bromiley, Govekar, & Markus, 1988) holds that all currently available public information about a given firm is reflected in that firm's share price. Therefore, if "a change in the stock return follows an environmental event that signals the environmental performance of the firm to the public, then we can assume that the market imputes a change in the net present **value** of the firm because of that event" (Klassen & McLaughlin, 1996: 1204). (3) Accepting the semi-strong form of the

Efficient Markets Hypothesis, we use stock returns as a measure of the market's perception of the future economic i mpact of the environmental initiative.

Type of greening initiative. To differentiate between the types of environmental initiatives, two trained raters (one assistant professor of management and one graduate student) read each of the printed announcements in their entirety and categorized them as being either process-driven or product-driven. The inter-rater reliability of this measure was 0.84. When differences occurred, the raters discussed the announcement and came to a consensus. It should be noted that no announcements of the installation of pollution control equipment were included in our sample. We feel that combining this type of post hoc initiative with more proactive/preventative ones blurs the conceptual distinction of process-driven initiatives. The installation of pollution control equipment is not a change to organizational processes themselves; instead, it is a reactive, end-of-pipe measure designed to (partially) offset the negative environmental effects of the firm's existing processes. Therefore, the motivation behind (and the a nticipated performance implications of) this type of initiative is likely different than other, more proactive environmental initiatives. In our analyses, the type of greening initiative was scored dichotomously, with process-driven announcements receiving a **value** of 0 and product-driven announcements receiving a **value** of 1.

Control variables. In addition to controlling for any confounding events, two other control variables were used in an attempt to increase the validity of our findings. First, we controlled for the reputation of the firm in question at the time of the announcement, because it is likely that investors' reactions to environmental initiatives will be different for "clean" versus "dirty" firms. Essentially, this was included as a control variable because of "surprise" or "departure-from-normal" issues. Investors will be caught off guard by announcements of environmental initiatives by firms that have "dirty" reputations and will not be surprised by announcements by "cleaner" firms. As a result, the magnitude of investors' reactions to announcements by "clean" versus "dirty" firms may be altered, making a firm's environmental reputation an important control variable. To assess each firm's environmental reputation at the time of the greening announcements in our sample, we again searched the Wall Street Journal. Be cause it is a primary source of financially relevant information for the investment community, we assumed that announcements in the Wall Street Journal played a major role in shaping investors' perceptions about firms' environmental reputations. For each firm in our sample, we gathered all environment-related announcements (broadly defined) printed in the Wall Street Journal for the five years immediately preceding the announced environmental initiative. The same two raters categorized the announcements as being positive, negative, or neutral. Inter-rater reliability was 0.93, and disagreements were again resolved by consensus. Favorable announcements were given a **value** of positive one and unfavorable announcements were given a **value** of negative one. Any neutral announcements were discarded. A firm's existing environmental reputation was then measured as the summation of all of its environmental announcements for the five-year period. The average firm had a score of 0.66, indicating a slightly positive reputa tion.

We also controlled for firm size, because investors may react differently to environmental announcements made by large versus small firms. For example, investors may view greening by smaller firms more favorably, because small firms may find it easier to implement greening initiatives, due to their higher levels of flexibility and lower levels of administrative burden. Firm size was measured as the log of sales the year of the announcement.

Analytical Techniques

As have many previous examinations of the relationship between anticipated economic performance and environmental performance, this study employs an event study methodology. To increase the strength of our design,

we closely follow the guidelines for event study implementation outlined in McWilliams and Siegel's (1997) comprehensive investigation of this method.

With event study methodologies, regressing the returns of each firm's common stock against the returns of the stock market index provides a predictive model. We used this regression's parameters to predict the expected returns for the firm's stock, adjusted for market movements on the days immediately surrounding the announcement of greening activities. The actual common stock returns on these days are compared to the normal/expected returns, and the differences may be called abnormal returns. We then averaged these daily abnormal returns across firms to provide mean cumulative average abnormal returns (CAARs). See the Appendix for details. In the absence of news impacting the **value** of a firm's stock, a firm's cumulative abnormal return should be **randomly** distributed and insignificantly different from zero (Fama, 1970). If, however, news reaches the market that influences the firm's long run **value**, the abnormal return will be significantly different from zero.

To test the direct effect of environmental initiatives on anticipated economic performance (in other words, to determine the statistical significance of the CAARs), we used Dodd and Warner's (1983) test statistic, Z. Because the abnormal returns were not perfectly normally distributed (skewness = 0.84, kurtosis = 1.93), we also used a Wilcoxon sign rank test, because this nonparametric test does not rely on the assumption of normality. To test for the differential effects of process-driven versus product-driven environmental initiatives, we divided the sample by type of initiative (process-driven vs. product-driven) and performed a t test for differences in means. We also used a nonparametric test, the Mann--Whitney Z-test, because of its robustness to possible violations of normality. Finally, using regression analyses, we examined the extent to which product- versus process-driven announcements influence the CAARs, controlling for firm reputation and firm size.

In each **analysis**, we examined a two-day event window, the day of the announcement and the day before. The rationale for this is that, although stock prices adjust quite quickly to reflect all publicly available information, some leakage of information may have occurred before public disclosure. Unlike many event studies, we chose a relatively short event window to more fully control for confounding information and reduce the likelihood of spurious results.

Finally, for each **analysis**, the critical p-**value** was relaxed to 0.10. This is due to our relatively small sample (especially with respect to our product- and process-driven subsamples) and a small-expected effect size (see Sauley & Bedeian, 1989).

Results

Means, standard deviations, and zero-order correlations for each of the variables in our analyses can be found in Table 1.

The results of our tests for the direct effect of announced environmental initiatives on anticipated firm performance are shown in section 1 of Table 2. The CAARs for the announcement period under investigation (Days -1-0) are not statistically significant. Therefore, contrary to hypothesis 1 and much prior research, our results suggest that, on average, corporate environmental initiatives have no direct effect on the market's perception of the firm's future economic performance.

The two remaining sections of Table 2 contain the results of our tests for the differential effects of process-driven versus product-driven environmental initiatives. Although no direct or overall effect of environmental initiatives on share price was found, it is nevertheless appropriate to examine these differential effects. Indeed, our inability to uncover a direct/overall effect may have occurred precisely because of the differential/moderating effect of type of initiative (see Bedeian & Mossholder, 1994). By aggregating the announcements, we may have been obscuring the relationships that exist. As shown in Section 2, stock market

reactions to product-driven greening initiatives were positive, but not significant. However, stock market reactions to process-driven initiatives were significant and negative. As Section 3 of Table 2 highlights, the t test for the difference in the means of the reactions to the two types of greening initiatives was significant (t = 2.03, p (less than) .05), indicating that th ere is a significant difference in investors' reactions to process-driven versus product-driven initiatives. The results of our nonparametric test were also significant (Z = 1.92, p (less than) .10).

We also tested hypothesis 2 using regression analyses, and the results are found in Table 3. As shown, we first conducted a simple regression for type of environmental initiative (process-driven vs. product-driven), with the abnormal return being the dependent variable. We then inserted the control variables into the equation and examined the product/process variable for significance. In each case, the results support the hypothesis that investors react more favorably to product-driven initiatives. For the full model, the type of greening initiative was a significant predictor ((beta) = 0.82, p (less than) .10) of abnormal returns. The sign of the regression coefficient indicates that investors reacted more favorably to product-driven greening initiatives, providing support for hypothesis 2.

Discussion and Conclusions

Although several prior studies have examined the direct effects of corporate environmental management on anticipated economic performance, there has been no attention given to the way in which different environmental initiatives may potentially influence it. The current study fills this gap in the literature by not only examining the potential direct effect of greening initiatives on stock returns, but also by testing the differential effects of process-driven versus product-driven initiatives. The results indicate that, although there is no overall effect of announcements of corporate environmental initiatives on anticipated performance, the type of environmental initiative announced does make a difference. These results are discussed more fully below, as are their managerial implications, the limitations of the study, and some suggestions for future research.

Environmental Initiatives and Anticipated Firm Performance

Although many prior investigations have found a positive relationship between environmental performance and anticipated economic performance, our results suggest no overall relationship. One reason for this difference in findings may be our implementation of the event study methodology. Most prior studies of the relationship between economic performance and environmental performance that used event study techniques failed to mention their treatment of several important methodological issues, such as controlling for confounding events.

Furthermore, the samples used in prior research were quite different from the current one. First, their data were often from only a few industries. For example, both Shane and Spicer (1983) and Stevens (1984) used only pollution control data from four industries, all of which were in the manufacturing sector and were considered to be "dirty." Also, Hamilton's (1995) study only included manufacturing firms, and Hart and Ahuja (1994) only examined mining and manufacturing firms. Again, these samples consist of firms in industries that may be considered "dirty." In the current study, both manufacturers and service firms from sixteen industries were included in the sample, providing a broader cross-section of organizations. Many of these firms are not in the manufacturing sector and may be viewed by investors as "cleaner," thus yielding a different market reaction. In addition, most prior research relied on third-party announcements of (generally negative) environmental issues. Our sample, on the contrary, consi sted only of reports of environmental enhancements. The contrast in findings between the current study and prior research of a main effect may imply that bad news has a stronger effect on stock price than does good news.

Although we found no overall effect of announced environmental

initiatives on anticipated performance, a more fine-grained examination of the data reveals that corporate environmental initiatives indeed influence investors' perceptions of future economic performance. After dividing the total sample into announcements of process-driven versus product-driven environmental initiatives, we found significant differences in anticipated future performance. More specifically, we found that investors reacted more positively to product-driven initiatives. From a reputation perspective, one reason for this finding may be that process-driven environmental enhancements do little to increase a firm's perceived reputation with stakeholders. The investment community was found to be less interested in organizational process changes and more interested in environmentally sound products or services. The potential reputation enhancing benefits of process-driven initiatives are not realized, translating into a negative market re action. However, it should be noted that the market's negative reaction to process-driven environmental initiatives might occur despite potential marginal increases in firm reputation that could accompany them. Many types of process-driven greening initiatives are mandated by government agencies and may be viewed as punitive in nature, rather than as proactive steps taken by firms to improve their competitiveness. Thus, a negative market reaction may occur despite feelings that marginal enhancements to firm reputation may occur through process-driven initiatives.

On the contrary, investors' reactions indicate that the introduction of environmentally friendly new products, or changes to the environmental impact of existing products, may boost organizations' reputations, thereby enabling organizations to achieve environmentally sustainable differentiation strategies (Shrivastava, 1995b). By enhancing the environmental reputation of one of the organization's product/service lines, firms pursuing product-driven greening may actually stimulate sales of their other offerings. In addition, firms that engage in product-driven environmental initiatives may discover process-related enhancements that could marginally improve firm reputation. In other words, there may be spillover effects of product-driven greening that enhance firm performance beyond just sales of the environmentally sensitive product itself. Thus, product-driven greening initiatives seem to increase investors' perceptions of organizational performance, even if a particular product is itself unsuccessful. In th is way, our results provide some support for Fombrun and Shanley's (1990) assertion that firms contributing to the social welfare will have better reputations. These increases in reputation, resulting from displays of social concern, manifest themselves in increases in share price.

Managerial Implications

Practicing managers must understand that all environmental strategies are not created equally. On the contrary, our study indicates that stock market reactions are significantly more positive to initiatives aimed at reducing the environmental impact of the firm's goods/services, perhaps because of the improvements in organizational reputation that can accompany them. Therefore, assuming that investors' reactions are indicative of firms' future economic performance, managers should seek to reduce the environmental impact of their existing products, as well as consider introducing new, environmentally friendly ones.

Our study suggests that the design and marketing of more environmentally sensitive products may be a better use of organizational resources than environment-related process changes. By channeling resources into environmental process enhancements instead of more traditional, **value** creating activities, we found that managers may actually be reducing their organization's anticipated future performance. This provides some support for Walley and Whitehead's assertions that managers should "seek to minimize the destruction of shareholder **value** that is likely to be caused by environmental costs rather than attempt to create **value** through environmental enhancements" (1994: 47). Therefore, it seems that organizations may want to reduce their emphasis

on lowering costs by creating more environmentally friendly production processes, and instead concentrate on improving the environmental performance of their products or services.

This is not to say that managers should be unconcerned with the environmental impact of their processes. On the contrary, the results of prior research indicate that there may be organizational benefits that result from minimizing the emissions of harmful chemicals, for example. Furthermore, environmental initiatives likely have **value**gt; in and of themselves. There are potentially far reaching social consequences associated with firms' environment-related decisions, and these consequences may not be captured by stock market reactions. On the other hand, it is possible that the investment community does understand these potential social consequences and builds those into their differential reactions. For example, as was mentioned previously, it is quite likely that product-driven initiatives will lead to improvements in the environmental impact of organizational processes themselves. Thus, market reactions may indicate that investors perceive more **value**gt; in firms beginning their environmental initiatives with cha nges to their products, while also taking advantage of any process-related spillovers that occur. In other words, our findings may not suggest that the market will punish firms that reduce their process-related environmental impact. On the contrary our findings may indicate that investors prefer firms to begin with product enhancements, and then let the product-driven initiatives guide the firm's process changes. In this way, our results could suggest that the investment community is attempting to alter the way in which organizations expend their environment-related efforts.

Limitations

By following McWilliams and Siegel's (1997) recommendations for the proper implementation of event studies, we have been able to overcome many of the major weaknesses of this methodology. For example, we examined only a short event window (2 days), eliminated from our sample announced initiatives from firms with other relevant announcements during that window, and reported nonparametric test statistics. Nevertheless, only one individual collected the original announcements, and it is possible that some relevant announcements were excluded based on the judgment of a single person. In addition, as with any event study, our conclusions rely largely on the validity of the semi-strong form of the Efficient Markets Hypothesis. Although there is a large body of evidence supporting this hypothesis (Fama, 1991), it is still the subject of some debate (see Megginson, 1997).

Also, some of our measures may not adequately represent the phenomena under study. In particular, our measure of a firm's preexisting environmental reputation is imperfect, because it ignores the magnitude of the favorable and unfavorable environmental announcements. It is highly likely that certain negative announcements (such as major environmental crises like large-scale oil spills) have much more dramatic effects on firm reputation than do others. Thus, the "counting" method used to measure environmental reputation is oversimplified. Also, investors' reactions to announced environmental initiatives might depend partly on the importance of the event to the firm. Therefore, some measure of announcement magnitude (such as the cost of the initiative relative to firm size) should be incorporated into future studies.

Finally, although we extended our announcement window to include the day before the announcement, we may not have adequately captured the full extent of information leakage. Whether certain parties have advanced knowledge of public announcements, and the length of time they have that knowledge, is difficult to determine.

Future Research

There are several promising avenues for future management research on environmental issues. First, although much work has been conducted to determine the organizational outcomes of environmental initiatives, little work has focused on the antecedents of greening activities. Organizational

slack, **historical**gt; firm performance (both economic and social), industry competitiveness, and others may make important contributions to firms' decisions to pursue environmental initiatives. Understanding the causes of organizational greening may help us to better understand its consequences.

Second, it may be worthwhile to examine the influence of environmental initiatives on overall organizational effectiveness and actual long run performance. Following Venkatraman and Ramanujam's (1986) suggestion that management researchers should examine more than just **financial**gt; performance, future research on organizational greening should consider the effects of environmental initiatives on such important outcomes as product quality and employee satisfaction. In addition, future investigations should attempt to determine whether stock market reactions are actually a good indication of the long run performance implications of organizational greening, an assumption inherent in our research.

Third, further refinement of the two types of environmental initiatives may be warranted, because process-driven and product-driven initiatives are each multidimensional concepts. For example, product-driven environmental initiatives may reduce the impact of a firm's products on the environment in at least two ways: when the products are in use and when they are being disposed of. Similarly, process-driven initiatives may be designed to either use fewer inputs to production or safer ones. Each of these may have unique performance implications and should be investigated in more detail.

Finally, a commonly accepted definition and measure of corporate environmental performance should be developed. Although third-party assessments and investors' reactions provide important insight into the issue, more work is needed to specify what exactly is meant by "environmental performance" and how that performance can be most accurately measured. Without a common definition and measure of environmental performance, our understanding of its antecedents and consequences will be hindered.

Conclusion

Given the significant impact that today's organizations have on the natural environment, research into the performance implications of environmental enhancements is important. In this study, we have attempted to further understanding of the expected performance implications of greening initiatives. Our results indicate that, despite the lack of a direct effect of greening on perceived performance, different types of environmental initiatives have unique implications. Our findings indicate that investors react significantly more positively to announcements of product-driven environmental initiatives relative to process-driven ones.

Notes

(1.) If stock markets are efficient, the market will anticipate the impact of an event on the firm currently and in the future. Since today's stock prices reflect future expected performance (see Brigham & Houston, 1999), when an event changes current stock prices, it is assumed to reflect changes in the market's expectations about the future. Whether or not markets are efficient and how strongly efficient is the subject of debate. However, after reviewing 180 studies on the subject, Fama concludes that, "... with respect to firm-specific events, the adjustment of stock prices to new information is efficient," and "event studies are the cleanest evidence we have on efficiency" (1991: 1602). Whether or not the market adjusts quickly to new information is also an important consideration. Fama also concludes that, "The typical result in event studies on daily data are that, on average, stock prices seem to adjust within a day to event announcements. The result is so common that this work now devotes little space to market efficiency" (1991: 1601).

(2.) Although many product-driven environmental initiatives necessitate changes in organizational processes (and vice versa), they are unique from process-driven ones, because the former is designed

specifically to generate revenues (through reputation enhancements), whereas the latter seems to be primarily designed to reduce costs by changing the underlying processes of the company. Thus, the motivation behind the greening initiative, as well as the content of the initiative itself, is important in distinguishing product- from process-driven greening. For example, it is clear that Toyota must make drastic changes to many of its organizational processes if it is to successfully introduce its new, energy efficient car. However, the primary focus of this strategic initiative is not to enhance organizational efficiency, decrease liability exposure, or reduce the firm's use of hazardous materials. On the contrary, this greening initiative is more likely designed to stimulate sales through an enhanced environmenta l reputation. Therefore, product-driven environmental initiatives are unique from process-driven ones.

(3.) If an environmental initiative is expected to impact future cash flows or risk, it could change the net present **value** of the firm. If markets are efficient, the stock price will adjust. As in any present **value** computations, changes in expected cash flows that occur early will have a larger impact than changes in cash flows that occur later. Therefore, if an announced environmental initiative will not impact expected cash flows for, say, 15 years, then the impact on the firm's net present **value** and stock price will be negligible.

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Descriptive Statistics and Correlations

	Mean	S.D.	1	2	3	4
1. Abnormal Return	0.01	0.25	1.00			
2. Product/Process-Driven (a)	0.45	0.50	.24 (*)	1.00		
3. Company Reputation (b)	0.66	1.17	-.05	-.13	1.00	
4. Firm Size (c)	9.00	1.47	-.38 (**)	-.15	.32 (*)	1.00

(*.)p (less than) .05
(**.)p (less than) .01
(a.)Product-driven announcements received a **value** of 1, and process-driven ones received a **value** of 0.
(b.)Summation of positive and negative environmental announcements for each firm.
(c.)Measured as the log of sales the year of the announcement.

Cummulative Abnormal Return for Days - 1 to 0

	CAAR	Z-Score	Wilcoxon Sign Rank Z
1. Total Sample	.01	0.05	0.52
2. Sub-Samples			
Product-Driven	.56	1.23	1.10
Process-Driven	-.45	-1.83 (+)	-2.13 (*)
		T-Score	Mann-Whitney Z-Score
3. Difference in Product- vs Process-Driven Sub-Samples		2.03 (*)	1.92 (+)

(+.)p (less than) .10
(*.)p (less than) .05.

Results of Regression Analyses (Dependent Variable is the Cumulative Abnormal Return)

Regression Number	Intercept	Product/Process Driven (a)	Company Reputation (b)	Firm Size (c)
1	-0.45	1.01		
	(-1.34)	(2.3) (*)		
2	-0.42	1.00	-0.03	
	(-1.11)	(1.98) (+)	(-0.16)	
3	4.63	0.78		-0.55
	(2.90) (**)	(1.68) (+)		(-3.25) (**)
4	4.92	0.82	0.18	-0.59
	(3.01) (**)	(1.72) (+)	(.87)	(-3.35) (**)

Regression Number	Adjusted (R^2) (F)
1	.04
	(4.11) (*)
2	.03
	(2.04)
3	.16
	(7.60) (***)
4	.15
	(5.30) (**)

(+.)p (less than) .10
(*.)p .05
(**.)p (less than) .01
(***.)p (less than) .001.
(a.)Product-driven announcements received a **value** of 1, and process-driven ones received a **value** of 0.
(b.)Summation of positive and negative environmental announcements for each firm.
(c.)Measured as the log of sales the year of the announcement.

Appendix

Event Study Methodology

We use event methodology to evaluate the stock market's reaction to

these environmental initiatives. The event study methodology was originally developed by Fama, Fisher, Jensen and Roll (1969), and we use the procedure as adapted by Dodd and Warner (1983).

For each security i, we estimate the market model parameters, (a.sub.i) and (b.sub.i) (the intercept and slope), by regressing each firms stock returns against the return on the market over the days -220 to -20 (the announcement day being Day 0). This regression's purpose is to model how the firm's stock price behaves as the entire stock market moves up and down. We use the regression parameters to measure how the firm's stock price would normally move on Days -1 and 0 if there were no environmental initiatives announced. For each firm i, we can compute the abnormal return on day t by comparing the actual return on that day, (R.sub.it) to the predicted returns, (a.sub.i) + (b.sub.i)(R.sub.mt). This means we compare how the firm's price actually changed compared to what was expected given how the market moved. The difference between actual and expected returns is called an abnormal return. The abnormal return is as shown in Eq. (1):

(AR.sub.it) = (R.sub.it) - ((a.sub.i) + (b.sub.i)(R.sub.mt))

where: (R.sub.it) = return on security i at time t;

(a.sub.i) = ordinary least square (market model) intercept;

(b.sub.i) = the ordinary least square (market model) slope; and

(R.sub.mt) = the return on the market on day t as proxied by the equally weighted CRSP index.

To measure the abnormal return over a specific **interval** (say, Day -1 to 0), we sum the abnormal returns for firm i to obtain the cumulative abnormal return, (CAR.sub.I) (Eq. (2):

(CAR.sub.i) = (((sigma).sup.(T.sub.2)).sub.t=(T.sub.1)) (AR.sub.it)

A firm's CAR will be positive if the environmental initiative announced is expected to increase the firm's **value**. In this case, the actual stock price movement would be larger than the expected price change that was obtained from Eq. (1). A CAR will be negative if the market perceives that the initiative will decrease **value**. Here, the firm's actual stock price change would be less than the expected change.

For a sample of N securities, the cumulative average abnormal return, CAAR is (Eq. (3):

CAAR = (((sigma).sup.N).sub.i=1)(CAR.sub.i)/N

If one firm has a positive (negative) CAR, this could occur by chance (as in any statistical test). However, if across a sample of announced environmental initiatives, a large number of the firms' CARs are positive (negative), we compute a Z statistic to determine their significance. After computing each firm's CAR, we have averaged them across firms.

The Dodd and Warner (1983) technique uses a Z test to determine if a CAAR is significantly different from zero. To compute the Z statistic, we first standardize each abnormal return as shown in (4) by dividing the (AR.sub.it) by its estimate for standard error, (S.sub.it) determined from the regression (Eq. 4):

(SAR.sub.it) = (AR.sub.it)/(S.sub.it)

To form the test statistic over the **interval** (T.sub.1) to (T.sub.2) (the starting and ending days used for announcement collection) we average the (SAR.sub.it) over each day in the **interval** as in Eq. (5):

(MSAR.sub.i) = (((sigma).sup.(T.sub.2)).sub.t=(T.sub.1))(SAR.sub.it)/(square root)(T.sub.2i)-(T.sub.1i)+1

For the overall sample, the test statistic is (Eq. 6):

Z=(((sigma).sup.N).sub.i=1)(MSAR.sub.t)/(square root)N

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Publisher Name: Elsevier Advanced Technology Publications
Descriptors: *Environmental policy--Laws, regulations, etc.
Event Names: *930 (Government regulation)
Geographic Names: *1USA (United States)
Product Names: *9980000 (Diversified Companies)
Industry Names: BUS (Business, General); BUSN (Any type of business)

30/9/12 (Item 12 from file: 15)
02100418 65399194

The nominal facts and the October 1979 policy change

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Review - Federal Reserve Bank of St. Louis v82n6 pp: 39-61
Nov/Dec 2000
CODEN: FRBRDV
ISSN: 0014-9187 Journal Code: FSL
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 23 Pages
Special Feature: Graph Table
Word Count: 8097

Abstract:

Researchers depend on observed regularities in macroeconomic data to guide the development of theory. One problem in developing monetary models of the business cycle is that there seems to be a great deal of instability in nominal data. Using data from 1959:Q1 to 1998:Q4 changes in the cyclical behavior of nominal data series that appear after 1979:Q3 when the Federal Reserve implemented a policy to end the acceleration of inflation are documented. Such changes in cyclical behavior are not apparent in real variables. It is concluded that, in order to find regularities in nominal data sets, it may be necessary to examine and compare episodes with similar monetary policy regimes.

Text:

There is a consensus concerning business cycle acts when the facts are about real variables. For example, Backus and Kehoe (1992) note that there is a similarity among covariance structures of real time series taken from different countries and from different sample periods within a country This consistency across data sets is no doubt one reason for the large amount of research on real business cycles.

This consistency does not extend to data sets that include money and prices. Backus and Kehoe (1992) found that the cyclical properties of money and prices were unstable across **historical** periods and across countries. Rolnick and Weber (1997) noted that the time-series properties of prices and money are very different in economies with commodity money standards than they are in economies with fiat money standards. Kydland and Prescott (1990) noted disagreement among economists about the cyclical patterns in prices. Wolf (1991), Cooley, and Ohanian (1991), and Pakko (2000) show that the cyclical behavior of prices in the United States varies from one episode to the next. Several researchers have attributed

this instability to changing policy regimes. For example, Friedman and Kuttner (1992) found that nominal-real relationships deteriorated following the Fed's policy change in 1979:Q3. Bryan and Gavin (1994) and Gavin and Kydland (1999) show that the correlations involving nominal variables of U.S. data are very different in the period from 1959:Q1 to 1979:Q3 than they are in data sets that begin in 1979:Q4.

Although economists looking for business cycle facts have tended to combine data across policy regimes and ignore the instability across the October 1979 policy change, many empirical research studies have limited their data to the post-1979 era.1 Also, many business economists have stopped using the pre-1980 data in the **financial** sector equations of forecasting models.2 Naturally, the instability caused by the policy shift is most acute in modeling the monetary policy reaction function. Empirical work in this area has been more careful about the break in the covariance structure associated with policy changes. Empirical studies on policy rules tend to split the sample in 1979 or to use data series beginning sometime after October 1982 when the nonborrowed reserve operating procedure was abandoned. See, for example, work by Coleman, Gilles, and Labadie (1993), Taylor (1993), Clarida, Gali, and Gertler (1998), Judd and Rudebusch (1998), Rudebusch and Svensson (1999), McNees (1992), Mehra (1999), Kozicki (1999), Salemi (1995), and many of the studies in Taylor (1999).

Our goal is to document the nominal facts using as little theory as possible. Gavin and Kydland (1999) calculated the cyclical properties of money and prices for the periods before and after the October 1979 policy change. In this article, we extend that work in several ways. We add four more years of data, and we examine the cyclical properties of nominal interest rates and inflation. Finally, we examine the covariance structure of several nominal relationships: the autocovariance of inflation, the lag from money growth to inflation, and the lag from money growth to nominal gross domestic product (GDP) growth.

In the first part of the paper, where we examine cyclical facts, we transform the data using the Hodrick-Prescott (H-P) filter. We have detrended all the series, including those for inflation and interest rates. We construct the trends using data from the full sample, 1959:Q1 to 1998:Q4, even in cases where we think there may be important breaks in the series, partly because we cannot be certain whether important breaks in the series do exist. Furthermore, even if such breaks exist, the problems in measuring the trend at the endpoints may be worse than the use of data across regimes. Throughout this first section of the paper, when we refer to a time series such as a monetary aggregate, GDP, or a price index, we are talking about the deviation of the logarithm of the variable from the H-P trend. Because there is some question about whether inflation rates and interest rates should be detrended, we also look at the cyclical properties of these series without filtering them.

The next section of the article looks at nominal growth rates. We do not use the H-P filter because we believe that, under fiat money standards, the interesting information in nominal data is the trend induced by monetary policy Although the Fed may have accommodated cyclical demands for money and credit, the behavior of inflation shows that the Fed has induced a long cycle that spans several business cycles. Figure 1 shows the consumer price index (CPI) inflation between 1959:Q2 and 1998:Q4. There was a long period of rising inflation from the beginning of our sample until the end of the 1970s. The inflation rate dropped rapidly in the three years beginning in 1979:Q4. Since then, the Fed seems to have followed a policy of maintaining inflation along a moderate and slightly declining trend.

THE MONETARY POLICY REGIME SHIFT IN OCTOBER 1979

We find a different set of empirical regularities for post-October 1979 than we find for the pre-- October 1979 period. It is useful to make a distinction between changes in the way the monetary policy decisions are made at Federal Open Market Committee (FOMC) meetings and changes in the way FOMC decisions are implemented by the Open Market Desk (Desk) at the Federal Reserve Bank of New York. In October 1979, both types of changes were made. After October 1979, the FOMC apeared to make policy decisions with more concern about deviations of inflation from the implied objective than they had before October 1979.3 The FOMC also changed the procedures the Desk used to implement the decision made at the meeting.

FOMC Decision Making

The FOMC sets the target for the policy instrument at FOMC meetings. This is a decision about where to locate the money supply function. The decision, both before and after the October 1979 policy change, was to supply reserves to lead to desired outcomes for inflation and output growth. Each decision was also expected to result in particular outcomes for the federal funds rate and the growth in the targeted monetary aggregates, particularly M1. A combination of theory, econometric models, and judgment went into these decisions. Before October 1979, monetary policy resulted in a high and variable outcome for inflation. After October 1979, the FOMC appeared to put relatively more weight on controlling money growth and inflation.4 Gavin and Kydland (1999) show that shifts of this sort would be expected to lead to significant shifts in the cyclical properties of nominal variables. This is the case whether or not the FOMC changes the way it implements the policy decision (its operating procedure).

The Operating Procedures

At the same time that it announced a new commitment to reducing money growth and inflation, the FOMC announced a change in the way the Desk would implement the decisions made at FOMC meetings.5 Prior to October 1979, the FOMC decided on a target for the federal funds rate-the market interest rate on overnight lending between banks. The FOMC would direct the manager of the System Open Market Account to buy and sell securities to maintain the interest rate near the target level. At each FOMC meeting, the staff of the Board of Governors would present the committee with estimates of how much money growth to expect from the alternative federal funds target choices. During the intermeeting period, surprises in the demand for reserves would be accommodated so that surprises in money demand showed up as variability in the quantity rather than the price of reserves.

On October 6, 1979, Fed Chairman Paul Volcker announced that the procedure would be changed so that the manager of the Desk would be required to adjust the Fed's **portfolio** of securities to achieve weekly targets for nonborrowed reserves, rather than the federal funds rate. The policy change led to a dramatic, tenfold increase in the volatility of the federal funds rate and a high correlation among changes in interest rates across the term structure and across national boundaries. The increased interest rate volatility caught the attention of the markets and the public. It probably helped Paul Volcker achieve credibility for the disinflation policy. Although inflation fell to around 4 percent at the end of 1982, M1 demand became more unstable, so the Fed shifted to borrowed reserves and returned to an operating procedure that was an indirect form of interest rate targeting.6 In Alan Greenspan's first term as Fed Chairman (which began in 1987), the FOMC returned to an explicit interest rate targeting procedure.

The change in the operating procedure had a predictable effect on the volatility of interest rates. We think it is important to consider the

interest rate correlations without the subperiod of reserve targeting. During this period the variation in interest rates associated with the operating procedure was large relative to variation in interest rates coming from other sources. However, this three-year period also included the longest and largest recession of the post-WWII era, so we are reluctant to exclude that period in all of our investigations. We note that none of the major results about the money stock, inflation, or the real economy would be qualitatively different if we had excluded that period from the **analysis**. In general, we think that the high-frequency correlations that are important for understanding **financial** markets would be affected by the operating procedure, but they are not the focus of this article. In our judgment, the cyclical effect of changes in the monetary policy decision-making process, even under very different procedures for implementing the decisions, will impact the aggregate price, money, and output data at business cycle frequencies in a similar manner. The effect of alternative operating procedures on the variability of interest rates was dramatic. However, the short period and severe recession that occurred during the period of nonborrowed reserve operating procedure makes it difficult to say whether the operating procedure had any effect on the cyclical behavior of interest rates.

We begin by reviewing the business cycle facts for the real variables and show that the covariance structure is relatively stable across the October 1979 policy change. Next, we examine the changes in the cyclical behavior of the monetary aggregates. Here the results are quite spectacular. There are dramatic changes in the behavior of all the monetary aggregates. Then we look at measures of the price level and inflation. Here the results for inflation are almost as dramatic as for the monetary aggregates, but the results for the price level are not. Next, we find that the cyclical behavior of nominal interest rates looks much like the behavior of inflation, suggesting that the expected inflation premium dominates the real interest rate as a source of cyclical variation in nominal rates. Finally, we examine the covariance structure among some nominal variables: the persistence of inflation as reflected in its autocovariance structure, the cross-- correlations between inflation and money growth, and the cross-correlations between growth rates in nominal GDP and four definitions of the money supply.

CYCLICAL PROPERTIES OF NOMINAL TIME SERIES

In Gavin and Kydland (1999), we found that changes in monetary policy affect the cyclical properties of nominal time series much more than they affect the cyclical properties of real time series. Before looking at the cyclical patterns in nominal variables, we begin by reviewing the cyclical behavior of the real variables. There are two differences from the work presented in our earlier paper. First, we use business sector output rather than GDP as the measure of output. Business sector output is the measure of output used by the Bureau of Labor Statistics to report on labor productivity The other difference is that we have extended the data set by adding quarterly data for the years 1995 through 1998.

Figure 1

We decided to use business sector output because it is the measure used to calculate productivity and it corresponds more closely with the concept of output that we typically use in macroeconomic theories. Using a different measure of output and adding four years to the sample do not change the results reported in our earlier paper. The cross-covariance structure among the real variables we examine-- real business sector output, personal consumption expenditures, expenditures on durables, expenditures on nondurables and services, domestic fixed investment, hours worked, and productivity-appears to be largely unchanged across the October 1979 shift

in monetary policy.

Figure 2 shows the cyclical patterns of real variables for the two periods. We measure cyclical patterns as correlations with the deviations of output from trend. For both of these periods and despite differences in data and time periods, the correlation coefficients are quite similar to those reported by Gavin and Kydland (1999) and earlier by Kydland and Prescott (1990). Hours worked as well as the components of consumption and investment are highly procyclical. There does appear to be a change in the cyclical behavior of productivity; it leads the cycle by two quarters in the earlier sub-sample, but appears coincident in the later period.

The last panel in the bottom right hand corner of Figure 2 shows the standard deviations for each of the variables over the separate periods. Consumption of nondurables and services is less variable than output, whereas expenditures on durables and all the components of investment are much more variable than output in percentage terms. In each case, the standard deviation is lower during the period following October 1979.(7) The biggest decline was in the standard deviation of productivity growth which was one third lower during the second period.

Table 1 presents evidence about the statistical significance of the differences in the correlation coefficients across sample periods. We constructed a Wald test to compare the null hypothesis-that the correlation coefficient in the latter period is equal to the correlation coefficient in the earlier periodwith the alternative hypothesis that they are not equal.8 If the two data series are treated as **random** samples drawn from a bivariate normal distribution, then the Wald statistic has a chi-square distribution with one degree of freedom. The 10 percent critical **value** is 2.71. Of the 77 statistics in the panel, 10 are equal to or greater than 2.71. That is, for 67 of the 77 statistics compared in Table 1, the evidence suggests that the behavior of real variables in the second half of the full sample is the same as that in the first half. There is some doubt about whether the macroeconomic variables can be assumed to follow a normal distribution-an important assumption for the reliability of the Wald test. We use a Monte Carlo method to check the reliability of the Wald test. We constructed small-sample critical values from 1000 repetitions of the following experiment. Using actual data from the earlier period (not deviations from trend), we estimated a bivariate vector autoregression that includes business sector output and one of each of the other variables. In every case, we recovered estimates of autoregressive parameters and the covariance matrix. Then these estimates were used with a **random** number generator to create 1000 artificial series for each pair. Each series is 160 periods long. These series were then detrended, the sample split at period 83 (corresponding to 1979:Q3 in the U.S. sample), and the cross-correlations calculated for each period. For each artificial series, the Wald test was constructed to determine stability across the two periods. The 1000 test statistics were sorted by size, and the one-hundredth largest is reported in parentheses below the Wald statistic. In every case for the real variables, the 10 percent critical **value** generated by this Monte Carlo method was larger than the asymptotic **value** implied by the bivariate normal assumption (2.71). This alternative testing procedure makes it more difficult to reject the null hypothesis, thus the conclusions regarding the changes in cyclical behavior have a conservative bias. In Table 1, you can see that the simulated small-sample 10 percent critical **value** is always larger than the Wald statistic calculated using actual data. Using this Monte Carlo distribution with the real variables, we cannot reject the null hypothesis that the same process generated the cross-correlations from both periods.

Money

In contrast to the real variables we examined in the previous section, the monetary aggregates behaved very differently during the period after October 1979 than they did before. We have included **analysis** of four alternative measures of the money supply. The narrowest aggregate included was the Federal Reserve Bank of St. Louis's adjusted monetary base (SL Base) as revised by Anderson and Rasche (1996). The transactions aggregate we included was money with zero maturity (MZM) rather than M1 because it includes the sweep accounts that distort the MI data after 1994; MZM is defined as M2 minus small denomination time deposits, plus institutional money market mutual funds. This aggregate was proposed by Motley (1988) and the label was coined by Poole (1991). Finally, we included M2, which is the Fed's primary monetary target and the M2 monetary services index (MS1M2) as constructed by Anderson, Jones, and Nesmith (1997).

Figure 2

The bottom panel of Figure 3 shows the standard deviation of the alternative measures of the money stocks for the two sub-samples. Substantial changes occurred in the variability of the monetary aggregates around trend. The narrow aggregates-SL Base and MZM-are less variable before 1979:Q3 than afterward, whereas the broad monetary aggregates-M2 and MS1M2-become less variable in the latter period.

There were also large changes in the cyclical correlations shown in Figure 3. Before October 1979, all four of the monetary aggregates were highly procyclical. The procyclical behavior practically disappeared in the second period. The contemporaneous correlation of the monetary base with real GDP falls from 0.47 to 0.11. The contemporaneous correlation of M2 drops dramatically, from 0.64 to 0.02. A similar drop occurred with the newer measures, MZM and MS1M2.

Table 1

Other than the dramatic change in contemporaneous correlations, there are few patterns shared by the cyclical behavior of the aggregates. In the earlier period, the SL Base lagged behind the cycle in output; after October 1979, it led the cycle by about a year. MZM and M2 led the cycle in both periods. The cyclical pattern for M2 before October 1979 was essentially the same as the cyclical pattern for MS1M2. But afterwards, they are quite different. Since then, M2 has led the cycle weakly while MS1M2 has lagged by two to five quarters.
The most important similarity among the monetary aggregates is that they all appear to be unstable across the policy regime switch in 1979.(9) In Table 2 we see that 32 of the 44 cross-correlations are greater than the theoretical asymptotic critical **value**, 2.71. Using this test, we can reject the hypothesis that the cyclical patterns were the same for all four definitions of money that we considered. When we compare the Wald statistics calculated from the data with the more conservative critical values from our Monte Carlo distributions (shown in parentheses in the bottom panel), we still find that 24 of the 44 are larger than the 10 percent critical values. Clearly, the cyclical properties are different in the two periods.

Prices and Inflation

Figure 4 shows the cyclical patterns for the price level measured by the CPI and the chain price indexes for personal consumption expenditures (PCE) and GDP. All display a similar pattern and a similar change after October 1979. The contemporaneous correlation in the earlier period was approximately -0.8 and rose by about 0.3 in the second period. The consumer

price measures lead output-with a negative sign-by two quarters in the earlier period and by four quarters in the latter period. The GDP chain price index appears to lead-again with a negative sign-by about one quarter in the earlier period and three quarters in the second period. Table 3 reports the tests for stability of the cross-correlations. We find that price and output correlations across the two periods are significantly different if we use the asymptotic 10 percent critical **value** (2.71). Using the more conservative tests, we cannot reject the hypothesis that the price-output correlations are the same across the policy regime switch. Note that this result changed after we added data for the four years 1995 through 1998. In Gavin and Kydland (1999), we found that some of the cross-correlations were significantly different for both the CPI and the GDP deflator even when we used the more conservative simulated critical values.

Table 2

The standard deviations for the price level (shown in the bottom right-hand panel of Figure 4) were slightly lower, on average, during the period following 1979 than they were in the period from 1959:Q I through 1979:Q3. Note, as depicted in Figure 1, the second period average masks a substantial dampening of the variability of inflation throughout the period. There was a dampening of inflation volatility after 1982 and another, more obvious, decline in the 1990s.

Figure 5 shows the cyclical properties of the different inflation rates when measured as deviations from the H-P trend. King and Watson (1994) noted that there was strong evidence of a Phillips curve relationship between the cyclical components of inflation and unemployment. Here we have used detrended output rather than the deviations of unemployment from trend. As suggested by the King and Watson paper, the contemporaneous correlation between deviations of inflation from the H-P trend and business sector output was positive in both periods for the consumer based measures. The cross-correlation with CPI inflation approximately doubled, rising from 0.22 in the pre-October 1979 period to 0.49 in the latter period. The correlation between inflation using the GDP chain price index and output rose from -0.01 in the earlier period to 0.34 in the latter period. Although the contemporaneous correlations are larger in the second period, the correlations are smaller at longer leads and lags. The top panel of Table 4 shows the Wald statistics and the simulated 10 percent critical values for testing the hypothesis that the correlations are equal across periods. Here, 25 of the 33 cross-correlations display a significant change when we use the asymptotic critical **value**. When we use the more conservative small sample critical values, we still find that 22 of 33 are significant.

Figure 3

Figure 4

Table 3

Figure 5

Figure 6 depicts the cross-correlations between detrended output and inflation without the H-P filter. This third method of comparing output and inflation corresponds to a common specification of these variables, as they typically appear in the aggregate supply function of macroeconomic models used by policymakers and their advisors. Inflation is slightly more variable if we do not remove the trend. There is a decline in variability of all three measures of inflation across the date of the policy regime switch. Using the H-P filter has a large effect on the measure of cyclical behavior. In Figure 5, where inflation was filtered, we reported large

negative leads in the early period that became smaller in absolute **value** in the later period. In Figure 6, where inflation was not filtered, the negative leads are smaller in the first period, especially for the GDP chain price index. However, in the second period, the negative leads are larger in absolute **value** if we do not filter the data.
The bottom panel of Table 4 shows the results when the data are not filtered. The only lead that has a significant change using the asymptotic critical **value** is for the GDP chain price index at a lead of five quarters. The lagged correlations are smaller in both periods if we do not filter the data, and they change in approximately the same way as in the case of the filtered data. There is a significant decline in the positive correlations for CPI inflation at leads of three, four, and five quarters that are significant even when we use the more conservative critical values computed in the Monte Carlo simulations.
Interest Rates

We conclude our discussion of the cyclical behavior of nominal variables with three market interest rates-the federal funds rate, the three-month Treasury bill rate, and the ten-year Treasury bond rate. As noted in the introduction, the method the Fed uses to implement FOMC policy decisions has an important effect on the time series properties of interest rates at high frequencies, days, weeks, months, and, perhaps, quarters. Although we investigated the effect of omitting the 1979:Q4 to 1982:Q3 data from all of our calculations, it only mattered in the case of inflation and interest rates. We will examine the post-1982:Q3 data for inflation in more detail in the next section. Here, we report cross-correlations between output and interest rates-both interest rates and output measured as deviations from the H-P trend-for three alternative periods: 1959:Q1 to 1979:Q3, 1979:Q4 to 1998:Q4, and 1982:Q4 to 1998:Q4.(10) Whether one should detrend interest rates depends on the question being asked of the data. Here, as was the case with inflation, we present the results both with and without the H-P filtering.

Table 4

We begin by examining interest rates after removing the trend with the H-P filter. Figure 7 shows how the cyclical patterns changed after October 1979. Whether we omit the three-year period from 1979:Q4 to 1982:Q3 or not, there is a dampening of the correlations after October 1979. The large negative correlations at leads of four and five quarters rise for all three interest rates from about -0.7 in the period before October 1979 to a range between -0.4 and -0.6 in the period after October 1979. The dampening also occurs at lags of three to five quarters. The large positive correlations at these lags falls for all interest rates from about 0.6 in the period before October 1979 to a range between -0.07 and 0.34 in the latter period.

Stability tests with filtered interest rates are shown in the top panel of Table 5. The upper three rows report results when we break the sample in October 1979. We can reject the hypothesis that the correlations are stable across the October 1979 policy switch; 20 of 33 Wald statistics exceed the 10 percent critical **value** (2.71) implied by the theory for large samples. When we compute the small-sample distributions using the Monte Carlo method, however, we find that only in the case of the contemporaneous correlation between the ten-year rate and business sector output can we reject the hypothesis that the correlations are equal across the policy regimes.

The next three rows in the upper panel of Table 5 report the results when we delete the three years 1979:Q4 to 1982:Q3 from the second period. There is a dramatic increase in the correlations contemporaneously-and at a one-quarter lead (shown in Figure 7). The important differences that result from omitting the three-year **interval** can be seen in our Wald

statistics. If we omit those three years and use the H-P filter on interest rates, then we can easily reject the hypothesis that the cyclical patterns are the same before and after October 1979. If we use the filter, the strongest rejections are of the leading correlations.

Figure 8 shows that, if we do not use the H-P filter, these interest rate correlations, compared with those in Figure 7, are about 0.3 to 0.4 smaller in absolute **value** in the first period and only about 0.1 smaller in the second period. Without the H-P filter, these correlations are about the same as those with the filter for the earlier period and are much lower than those for the latter period.

Figure 6

If we do not use the H-P filter, the leading correlations appear more similar across policy regimes, but the lagging correlations are significantly different. The bottom panel of Table 5 reports the tests for stability in this case. Using the asymptotic critical **value** of 2.71, we can reject stability for the leading correlations only in the case of the ten-year bond rate. On the other hand, we can reject stability in the lagging correlations for all three interest rates even when using the more conservative small-sample critical values.

The pattern for interest rates closely mimics the pattern for inflation. In all periods shown, interest rates have a negative correlation with output at leads, then turn positive both contemporaneously and at lags. The change in policy regime mainly raised the correlation at leads and lowered the correlation at lags. The changes in the patterns observed for inflation when not using the H-P filter (see Figure 6) are similar to the patterns we see when not using the H-P filter on interest rates.

Summary of Facts about the Cyclical Properties of Nominal Times Series

The adoption of a disinflation policy in October 1979 does not appear to have had a measurable impact on the cyclical properties of real variables.. However, it made a dramatic difference in the cyclical properties of nominal variables. The cross-correlations between the monetary base and business sector output switched signs after the policy regime changed. Negative leads turned positive and positive lags became negative. For the other monetary aggregates, positive leads became smaller and usually insignificant. Generally, the monetary aggregates appear to be less cyclical after 1979.

Price indexes were generally countercyclical in both periods, but the cross-correlations became smaller in absolute **value** after 1979 and the lead became longer. The absolute sizes of the negative correlations were largest between leads zero and two before October 1979 and between leads three and four in the period afterwards.
Figure 7

Table 5

Figure 8

We examined the cyclical properties of inflation both with and without H-P filtering because both specifications are used in empirical studies of the aggregate supply function. Before October 1979 there is a strong cyclical pattern-a phase shift from the pattern observed for the price level. There is a relatively large negative correlation at leads and a large positive correlation at lags. After 1979, the pattern flattened for all the price indexes. The changes were highly significant. Without the H-P filter in the earlier period, the negative values at leads were close to zero and

positive values at lags became as large as 0.4. After October 1979, the negative leads became somewhat larger, but contemporaneous and lagging correlations were close to zero. The cyclical patterns for market interest rates mirrored the patterns observed in the inflation rates.

NOMINAL GROWTH RATES

In the previous section, we examined the business cycle properties of nominal variables using the H-P filter to define the cyclical component. In this section, we examine the relationship among nominal growth rates where the trends are determined by monetary policy. As we saw in Figure 1 and discussed in the introduction, policymakers allowed the inflation rate to drift upward over the period between 1959 and 1980. They appeared to be focused more sharply on the real variables than on controlling inflation. After October 1979, the Fed appeared to be putting relatively more weight on controlling inflation. We examine the covariance structure of data sets that contain growth rates of eight nominal variables: four measures of the money stock (SL Base, MZM, M2, and MS1M2), three price indexes (CPI, PCE chain price index, and the GDP chain price index),

and nominal GDP. We begin by comparing simple descriptive statistics-means, standard deviations, and the autocorrelation functions-before and after the October 1979 policy switch. Next, we examine the cross-correlation functions between inflation and different measures of monetary growth. Before concluding, we also report the cross-correlations between nominal GDP and monetary growth.

For almost all of our results, omitting the period from October 1979 to October 1982 does not make much of a difference. We note the one case where there was an important difference. We decided to omit those three years in this section because

* it was a transition period when people were learning about the new policy regime;
* there were many regulatory changes during this period which caused abrupt shifts in the time series for measures of the money stock; and

* the nonborrowed reserve operating procedure affected the data at high frequencies and using a first-difference filter emphasizes the time series properties at high frequencies.

In all of the results reported for nominal growth rates, we are comparing statistics from the period 1959:Q1 to 1979:Q3 with the period from 1982:Q4 to 1998:Q4.

The Time-Series Properties of Money Growth, Inflation, and Nominal GDP Growth

As we saw in Figure 1, the important aspect of the policy regime switch was the successful stabilization of inflation at a moderate rate. The average inflation rates were not that much different-the largest difference was in CPI inflation that averaged 4.2 percent in the first period and 3.2 percent in the second. However, there was a large increase in inflation from the early 1960s to the late 1970s, whereas the inflation rate was much more stable after 1982. There was a slight upward trend in the 1980s that reversed in the 1990s.

Somewhat surprisingly, average growth rates of the narrow measures of money, SL Base and MZM, are actually larger following the successful disinflation policy (see top panel of Figure 9). For the non-interest-bearing components of these narrow aggregates, this surprising result can be attributed partly to the one-time shift in the level demand

for money that comes from a lower nominal interest rate. Nominal interest rates generally declined from 1982 until 1993. For example, the three-month Treasury bill rate declined from over 8 percent in the first half of 1983 to an average of about 3 percent in 1993. There was also a large demand from abroad for currency in the 1980s as the Soviet Union broke up and some high inflation countries in Latin America began to use more U.S. currency. For the interest-bearing components, the more rapid growth can be attributed to changes in regulations that allowed banks to pay interest on checkable deposits and offer easy access on demand for some savings-type deposits. These zero maturity deposits are included in MZM and grew rapidly after 1982. The two broad measures of money, M2 and the MS1M2, were lower in the second period.

The variability of the monetary growth rates is about the same or greater after 1982 than it was before 1979-much greater for MZM and slightly less for MS1M2 (see bottom panel of Figure 9). The variability of inflation and nominal GDP growth was substantially lower in the second period than it was in the first.

As shown in Figure 10, the autocorrelation coefficients for the growth rates of the narrow monetary aggregates, and all three measures of inflation, decay faster after 1982 than they do before October 1979. The autocorrelation functions for M2 and MS1M2 actually rise in the second period for lags of three quarters and higher. The largest shifts in autocorrelation functions for measures of the money stock occur in the cases of SL Base and M2 (see Table 6).

Table 6 shows that the shifts in the cases of the chain price indexes are generally not statistically significant if we use the Monte Carlo critical values. The most significant declines were in the autocorrelations of CPI inflation. This is the one case where excluding the three interim years, 1979:Q4 to 1982:83, was important. If we include these years, we find a more modest decline in the autocorrelation function except at the longest lags.

The Lag from Money to Prices

It is conventional wisdom among macroeconomists and policymakers that there is a long and variable lag between money and prices.11 Work by Irving Fisher during the early part of this century indicated a much shorter lag than is typically found in more recent studies. He thought the lag would be no longer than three months:

It was in August, 1915, that the quantity of money in the United States began its rapid increase. One month later prices began to shoot upward, keeping almost exact pace with the quantity of money In February 1916, money suddenly stopped increasing, and two-and-a-half months later prices stopped likewise. Similar striking correspondences have continued to occur with an average lag between the money cause and the price effect of about one-and-three quarters months. (Fisher, 1918, p. 5)

In a recent study using U.S. data from the period from 1965:Q3 to 1995:Q2, Christiano, Eichenbaum, and Evans (1997) report that, following a contractionary monetary policy shock, "The GDP deflator is flat for roughly a year and a half after which it declines" (p. 23). One explanation for the difference in perceptions of the lag is the difference in monetary policy regimes. Our premise is that the variable lags reflect the expectation effects of variation in policy regimes.

That there will be differences in measures of the lag before and after 1980 is apparent in the data. The cross-correlations between CPI inflation and monetary growth are shown in Figure 11. As the upper left hand panel shows,

quarterly series of monetary base growth and inflation were highly correlated in the period before October 1979. Afterwards, the cross-correlation between the two series is approximately zero for all lags from zero to twelve quarters. As Table 7 shows, the change in the cross-correlations between the monetary base and inflation are larger and more significant than the changes for any of the other aggregates. The values from the Wald test for equality of the correlation coefficients are larger than the Monte Carlo 10 percent critical values for the contemporaneous and 12 lags of monetary growth. The result is not as strong for the other aggregates, mainly because there was not much correlation between money and prices at short lags for MZM and the M2 measures. At lags of six quarters or more, the early period cross-- correlations were relatively large and, using the theoretical asymptotic critical **value**, the correlations were all significantly smaller after 1982. However, only in the case of M2 can we consistently reject equality across the two periods using the more conservative Monte Carlo critical values.

Figure 9

Figure 10

In the early period, monetary policy allowed the average inflation rate to ratchet upward with each business cycle. This policy was associated with high variances in nominal growth rates and high cross-- correlations between monetary base growth and inflation. When the Fed adopted a successful policy to stabilize inflation at a moderate rate, the cross-- correlations with the monetary base went to zero and the autocorrelations of inflation measures decayed more quickly.

The Lag from Money to Nominal GDP

Many economists supported monetary targeting in the 1970s because of the close relationship between growth rates of the money stock and nominal GDP. The St. Louis equation developed by Andersen and Jordan (1968) was based on this relationship and was the foundation for many small forecasting models until the early 1980s. The breakdown in the relationship between money and nominal output then led many economists to lose confidence in the reliability of monetary targeting as a strategy for running policy.

In earlier sections, we documented a dramatic shift in the cyclical behavior of the monetary aggregates and a significant shift in the relationship between money growth and inflation. Therefore, we also expected to see a change in the cross-- correlations between nominal GDP growth and monetary growth. As Figure 12 shows, this was the case with the SL Base and MS1M2, but not with MZM or M2. In the earlier period, growth in nominal GDP was correlated with contemporaneous SL base growth and lagged SL base growth for approximately the previous six quarters. The correlation was highest-nearly 0.5-at the first lag and tapered off to values of 0.2 or lower at longer lags. In the second period, the contemporaneous correlation was 0.1 and rose gradually to peak around 0.3 at lag seven and then fell to zero at lag ten. In the case of MS1M2, the cross-correlations at short lags were lower in the second period. As shown in Table 8, the Wald test rejects equality at the second and third lags.

Table 6

Figure 11

Table 7

Figure 12

Table 8

Summary of Fads about Nominal Growth Rates

Generally, monetary policy in the early period allowed the average inflation rate to ratchet upward with each business cycle. This policy was associated with high variances, high autocorrelations, and high cross-correlations among nominal variables. The moderate inflation policy that followed in the second period was associated with lower mean growth rates, less volatility, and lower cross-- correlations.

The cross-correlations between nominal GDP growth and growth in MZM and M2 seem to be approximately the same across the October 1979 regime switch. The biggest differences were in the cross-correlations with the monetary base.

CONCLUSION

There are important implications of this paper for building monetary models. Our results show that researchers should take care when they assume that the covariance structure of data sets is stationary Our results suggest that is generally not the case for nominal time series spanning a time period that includes October 1979. The strategy of modern macroeconomics is to build general equilibrium models and compare the covariance structure of data implied by the model to the covariance structure observed in the data. Large deviations signal areas for further research. This research strategy has worked better in real business cycle studies because the covariance structure of real variables seem to be relatively stable across countries and policy regimes. It has not worked so well in monetary business cycles because there is no general agreement about the facts. Our results suggest that one way to find regularities in the data may be to examine and compare episodes with similar monetary policy regimes.

1 Kydland and Prescott (1990), Cooley and Hansen (1995), Fuhrer and Moore (1995), and Stock and Watson (1999) report statistics on the cyclical properties of nominal variables using data sets that span the October 1979 policy shift.

2 See, for example, the forecasting model of Macroeconomic Advisors, LLC, in which the term structure equation and monetary policy reaction function are estimated using only post-1982 data.

3 See Clarida, Gali, and Gertler (1998), McNees (1992), Salemi (1995), and Chapter 7 in Taylor (1999) for econometric evidence about the Fed's reaction function in the two periods. All find a significant increase in the Fed's relative concern about inflation after October 1979.

4 See references cited in footnote 3.

5 See Gavin and Karamouzis (1985) for an elementary description of the alternative operating procedures.

6 See Thornton (1988) for an empirical **analysis** of the distinction (and similarities) between the Borrowed-Reserve operating procedure adopted in 1982 and an interest rate procedure.

7 See McConnell and Quiros (2000) for a discussion of the decline in output volatility after 1984.

8 See Ostle (1963). pp. 225-7, for a detailed description of the test statistic used.

9 Freidman and Kuttner (1992) also have documented the instability in the

monetary aggragates across the 1979 policy regime switch.

10 Deleting the first three years had almost no effect on the measured cyclical pattern of the level variables examined in this study, except interest rates.

11 See Freidman (1961) for an influential discussion of this issue. Bryan and Gavin (1994) and Gavin and Kydland (1999) explore the possibility that the variable lag may be due to instability in the policy function.

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Geographic Names: United States; US

Descriptors: Economic theory; Monetary policy; History; Variables; Economic stabilization; Regression analysis; Studies
Classification Codes: 1130 (CN=Economic theory); 9130 (CN=Experimental/Theoretical); 9190 (CN=United States)
Print Media ID: 23954

30/9/13 (Item 13 from file: 15)
02100400 65357175

What P/E will the U.S. stock market support?

White, C Barry
Financial Analysts Journal v56n6 pp: 30-38
Nov/Dec 2000
CODEN: FIAJA4
ISSN: 0015-198X Journal Code: FIA
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 9 Pages
Special Feature: Formula Table
Word Count: 5512

Abstract:

The purpose of this study was to determine the earnings multiple of the US stock market that can be justified by economic fundamentals at any given time. When price to earnings or earnings to price was used as the dependent

variable, several regression models were found to be significant. The final E/P model had eight significant variables and explained more than 88% of P/E variation. This model indicates that today's multiples of 30 to 35 are not justified by current or expected economic conditions.

Text:

The purpose of the study reported here was to determine the earnings multiple of the U.S. stock market (proxied by the S&P 500 Index) that can be justified by economic fundamentals at any given time. When price to earnings or earnings to price was used as the dependent variable, several regression models were found to be significant. The final EIP model had eight significant variables and explained more than 88 percent of PIE variation. This model indicates that today's multiples of 30 to 35 are not justified by current or expected economic conditions.

In December 1996, U.S. Federal Reserve Chairman Alan Greenspan asked a widely reported question that sent the market temporarily plummeting: "How do we know when irrational exuberance has unduly escalated asset values?" At that time, the market earnings multiple was about 20. Recently (this article was written in mid1999), it has been 30-35. Is the current stock market rationally priced? How much should investors pay for $1 of net after-tax earnings?

The prudent investor wants to know whether the market is underpriced or overpriced in light of the quantifiable economic conditions of the time. Since 1926, when reliable records began, the priceto-earnings ratio of the S&P 500 Index has averaged 14.4 and ranged from a low of 5.9 in 1949 to a high of about 35 in 1999. A dollar per share of earnings could be worth $5.90 a share or $35.00, more than five times as much. Why the wide disparity? Which **value**, if either, is justified?

The most famous example of irrational pricing is the Dutch tulip bulb craze of the early 1600s. Greed and speculation drove tulip bulb prices to truly ridiculous levels. Moreover, this happened in the staid, conservative environment of Holland. Introduced to the Dutch in 1593, the tulip became a nice addition to gardens during the next 10 years. At that time, it was merely "expensive." As tulipmania set in, viruses were introduced to the tulips to develop more exotic varieties. As stated by Malkiel (1990), "The more expensive tulips became, the more people viewed them as smart investments" (p. 35). By 1635, people were trading their homes and large plots of land for a single tulip bulb in the hopes of becoming wealthy. Investors at that time believed these elevated prices to be fair, but in 1637, the bubble burst and tulip bulbs became worth less than one-tenth of their previous high prices.

Speculation has taken hold in the U.S. stock market numerous times-with similar results. From March 1928 through August 1929, for example, large-company stock prices rose 94 percent, more than the previous five years combined. People were borrowing money to invest in a market they believed could not go down. At the time, an investor (or speculator) could borrow up to 90 percent of the purchase price, and many did. Then, as now, stock investing infiltrated most serious conversations. Prices began to fall in September 1929 and then plunged 20 percent in October. By the end of 1932, large-company stocks were selling for 27 percent of their August 1929 highs.

In the early 1970s, stock prices were driven up by the "Nifty Fifty," a group of well-known growth companies that included Sony Corporation, Polaroid Corporation, and McDonald's Corporation. Nifty Fifty companies were trading at 60-90 times earnings while the market as a whole had a P/E of about 18. In 1973 and 1974, largecapitalization stocks as a group lost

37 percent of their **value** and their P/E multiple fell to 7. Smallcap stock prices fell even further.

Market P/E trends seem to prevail for extended periods of time. The P/E increased without a noticeable break from the first quarter of 1942 to the second quarter of 1946, much of which time covered World War II. Then, it plummeted, falling to 6 by the second quarter of 1949. The earnings multiple then grew, with a few minor pullbacks, from about 6 to above 22 in fourth quarter 1961. The P/E next zigzagged downward to 7 in 1980 before oscillating up to more than 30 in 1998. Returns have been unusually high since 1995 (37.4 percent in 1995, 23.1 percent in 1996, 33.4 percent in 1997, and 28.6 percent in 1998), and volatility has been unusually low since 1993. Price levels grew faster than earnings as the market was undergoing this P/E expansion.

The study reported here attempted to develop a tool to give some indication of when stocks have become priced irrationally high given the prevailing macroeconomic conditions. Previous studies of the determinants of stock prices, returns, and P/Es, together with theory and logic, were the basis for this study. With the advantage of knowing which independent variables were significant in past studies, I expected to be able to develop a model that would explain a large portion of variation in P/E.

Many factors are believed to influence what P/E the market will support. Current inflation and long-term bond yields are thought to be two of the major factors. Analysts and academics have long believed that stock prices are inversely related to inflation and the resulting interest rates. Past studies have also linked P/E to earnings growth, dividend payout, volatility of returns, and liquidity. The hypothesis I propose is that, in addition, short-term rates (represented by U.S. T-bills), the aggregate dividend yield (for the S&P 500), dividend payout ratio, money supply, Federal Reserve P/E index, earnings growth, GDP growth, and volatility and total return of the S&P 500 will all influence the P/E that the market is willing to pay for equities. In my study, P/E was the dependent variable and all other variables were independent. The research hypothesis was that a significant relationship exists between each independent variable and the dependent variable.

Econometric studies such as this one normally use ex post information. After investigating several model specifications, the best model is selected for publication, which induces an upward bias to the models' explanatory abilities. I continued this tradition by using the best models from past studies and improving on the models by adding other suspected significant variables. Thus, this study is surely biased upward in its explanatory power. And if the model I used shows the current market P/E to be exuberantly high, buyers should beware.

Previous Studies

The first question is: Are P/Es good indicators of future stock returns? Some theorists believe consumption drives stock returns; others say returns are driven by increased investment by the populace. An increase in allocation to stocks by the average investor can drive equity prices higher. As stated by Fama (1991), an economy must have increasing consumption to support higher earnings if higher equity prices are to be justified and sustainable.

Bleiberg (1989) investigated how subsequent returns can be predicted by P/E multiples. Using quarterly S&P 500 data from 1938 through 1988, Bleiberg found that when the P/E was in the top quintile of its **historical** range, average returns were -0.68 percent over the next 24 months. A rising market existed, however, more than half the time

(54 percent) in the 24 months following a very high P/E (mid-1996 to 1999 is an example). Returns fared much better following a lowest-quintile P/E; they averaged 29.79 percent annually in the next 24 months. Bleiberg's conclusion was that an investor cannot effectively use P/Es to time the market because "an 'overvalued' market can do well for quite a while" (p. 31). Thus, P/E can be used only as a mild indicator of what is likely to occur in the subsequent 24 months.

A more recent article (Campbell and Shiller 1998) concluded that **valuation** "ratios are extraordinarily bearish" (p. 24). Campbell and Shiller used annual data back to 1872 to study stock returns as a function of dividend yield (dividend/price). With a **historical** mean D/P of 4.73 percent, the early 1997 D/P of 1.9 percent (1.2 percent in early 1999) was cause for concern. When D/P fell below 3.4 percent during the period, the stock market always declined in real terms before it again crossed through the D/P **historical** mean. The authors stated that

valuation ratios may be extreme today because baby boomers are willing to pay high prices for stocks. The ratios may remain extreme for as long as this demographic effect persists-and may even move farther outside their **historical** ranges if the demographic effect strengthens. (p. 18)

Campbell and Shiller pointed out that high stock prices and P/Es are often justified by low inflation because since 1960, D/P has moved closely with the inflation rate and parallel to long-term government bonds.

A 1993 study by Goetzmann and Jorion investigated the effectiveness of dividend yield in predicting stock returns in the subsequent four years. They used monthly S&P 500 data from 1927 through 1990 and found, as expected, that returns increased strongly with higher dividend yield.

Good's 1991 paper investigated returns as a function of P/E. Using quarterly 1955-90 data, he concluded that subsequent 12-month returns could be predicted only when P /Es were very high (over 20) or very low (below 8). In his sample, a very low P/E was a portent of a return of about 20 percent on average whereas a very high P/E was commonly followed by a 5 percent loss in the next year. The majority of earnings multiples observed fell between 8 and 20 and gave no hint of future returns.

The next question is: What determines P/E? In their 1978 article, Beaver and Morse used NYSE data for 1956-1975 to analyze earnings growth and volatility as determinants of P/E. Numerous money managers, then and now, have used expected earnings growth as a measure of the earnings multiple they will pay for a stock. The problem is that long-term earnings are difficult to predict. Moreover, past growth and future growth have a correlation near zero.

Finance theory predicts P/E by using the wellknown constant-growth dividend discount model:

Thus, P/E should increase with a rising dividend payout ratio and growth but decrease with a higher required rate of return. As volatility of returns increases, so does the required return, which drives P/E lower. Beaver and Morse showed that, on average, volatility and earnings growth explain 50.5 percent of the variation in P/E. They used earnings return (E/P) for the regression rather than P/E because E /P is believed to exhibit linearity whereas P/E does not. The E/P fell with increased growth, as expected. Growth predictions beyond two years had no explanatory power. Beaver and Morse stated that "the pattern behaves as if market participants, in determining prices, cannot forecast differential growth beyond two years" (p. 69).

Reilly, Griggs, and Wong (1983) ran multiple regressions with 1962-80 S&P 400 Index data, in which they used P/E as the dependent variable. They found that inflation had a negative correlation with P/E. The earnings multiple moved with prior-period earnings growth, dividends to earnings, and oddly, the business failure rate but moved against inflation and the risk-free return. Reilly et al. concluded that the business failure rate was not a reliable P/E indicator for the period studied. As theory would suggest, the authors indicated that P/E would rise with dividend growth rate and fall with increased required rate of return and earnings volatility.

A 1994 study by Nomura Securities and Dorfman showed how P/Es actually responded to inflation from 1955 to 1994. The obvious conclusion from this study is that higher inflation depresses P/Es. As Table 1 shows, the category of less than 3 percent inflation had twice the frequency of any other category (and probably should have been broken down into smaller increments). A regression study might have been even more useful because it would not have had the restrictions of categorical (ordinal) data.

A study by White (1997) also addressed inflation directly. As suspected, inflation was found to have a reasonably high negative correlation with P/E. High inflation causes high interest rates, which raise a corporation's borrowing expense while, at the same time, making bonds relatively more attractive than stocks. In this 1997 study of annual S&P 500 data for the 1956-95 period, inflation ranked third in explanatory **value** when simple regressions were used. Ninety-day notes (banker's acceptances) ranked second in explanatory power, and dividend yield ranked first. The best multiple regression showed P/E to be inversely related to GDP growth, inflation, and dividend yield (R2 of 83 percent).

Table 1.

A 1970 paper by Malkiel and Cragg used 196165 data in a study of the determinants of P/E for 178 companies. Their best model for predicting the P/E of an individual company included expected earnings growth, dividend payout ratio, **financial** leverage, and an instability index (volatility of operating earnings). The most powerful variable was expected earnings growth with a positive coefficient. Malkiel and Cragg also discussed theoretical factors affecting P/E. They posited that the earnings multiple will rise with dividend payout and earnings quality (sustainability of earnings growth) and will fall with increased volatility in annual earnings and returns.

Kane, Marcus, and Noh (1996) used monthly S&P 500 data for 1954-1993 to study P/E as a function of market volatility. Their main conclusion was that if the standard deviation of returns increases on a "permanent" basis, the market P/E will fall. P/E did not fall in late 1987 because the extreme volatility was not believed to be permanent. The authors theorized that the market risk premium and required return should rise with volatility, which should lower the P/E because uncertainty surrounding earnings forecasts increases. The P/E multiple increased with lagged P/E and the default premium on corporate bonds, whereas it decreased with higher market volatility, inflation rate, and industrial production. Lagged P/E was, by far, the most powerful predictor of current P/E. Because beta and correlation are related by the ratio of the standard deviations of the two variables in question, a high correlation, and thus serial correlation, is suspected between P/E and lagged P/E.

Loughlin (1996) used quarterly data from 1968 to 1993 to study the determinants of P/E for the S&P 500. He found dividend payout to be positively related to P/E and the variable with the most explanatory power.

In his multiple regression model, the rate on five-year Treasury notes was the second most powerful variable and was inversely related to P/E. The only other statistically significant variable was expected earnings, with a positive coefficient.

Fairfield (1994) focused on profitability and dividends as determinants of P/E and price-to-book **value**. She investigated a large number of companies for the 1970-84 period and followed each company for five years. Fairfield postulated that P/E equals the inverse of required return plus "the capitalized present **value** of expected growth in abnormal earnings" (p. 25). The data showed, as expected, that P/E was higher for companies having higherthan-average five-year growth. High P/Es were also associated with lower-than-average earnings growth for the current year; companies with temporarily depressed earnings had high P/Es.

Zarowin (1990) studied E/P rather than P/E because he believed E/P to be a linear function with respect to risk and earnings growth. Based on his cross-sectional study of 89 NYSE companies for 1964-1968, he concluded that "persistent differences in forecasted long-term earnings growth are the dominant source of variation in earnings-price ratios" (p. 439). As expected, E/P fell with higher short-term and long-term earnings growth (the most powerful predictor). Past volatility (risk) was not a significant determinant.

Cho (1994), whose study was partially based on Zarowin, used E/P because he believed that E/P exhibits linearity whereas P/E does not.1 Cho studied 1,005 companies for the year 1988. He found the significant determinants of E/P and their relationships with E/P to be as follows:

* E/P rises with increased standard deviation of earnings forecasts.

* E/P rises with a lower five-year forecast of earnings growth.

* E/P rises with a lower dividend payout.

(Of course, P/E would have the opposite relationships.) The regression explained only 7.5 percent of the variation, however, in E/Ps. Cho found that another cross-sectional model, which used ex post measures of risk and growth, showed the same relationships and had an R

sup 2

of 10 percent. He thus concluded that using 36-month trailing standard deviation and earnings growth might be just as instructive as using predictions.

Theory and Model Construction

Maginn and Tuttle (1990) posited that price and P/E increase with return on equity (ROE), with book **value** divided by earnings, and with dividend growth and that they decrease with higher expected return. They described the relationship as follows:

money supply, GDP growth, trailing earnings growth, long-term T-bond rates, and trailing volatility. The new variables are the Federal Reserve P/E index and trailing S&P 500 returns. The Federal Reserve P/E index is the P/E that the Fed purportedly believes is justified by current 10-year Treasuries (compare the inverse of the 10-year Treasury yield to the forward P/E of the market). The rationale for using trailing S&P 500 returns is that investors appear more likely to pay high prices (and the resultant high P/Es) following several years of superior equity market returns. All the dependent and independent variables are defined in Exhibit

1.

Data and Design. For this study, quarterly time-series data were used for each of the variables from 1926 through 1997.2 During this time, unforeseen, catastrophic events often had a profound effect on the **financial** markets. The Great Depression, World War II, the Vietnam War, and high inflation-- all occurred in this period.

In the multiple regression used to examine P/E, all the variables were ratio data, meaning they had an absolute zero and I could perform mathematical operations on them. Exhibit 2 shows the relationships expected between P/E and the independent variables. A 5 percent level of significance was used. I ran multiple regressions using all variables in order to discover the highest possible level of explanatory power (R

sup 2

). Because some studies have declared the superiority of E/P regressions, I ran them also to determine whether they have more explanatory ability than P/E regressions.

Computed t-values were used to evaluate the independent variables, and I examined multicollinearity among the independent variables to see whether it was a concern. I tested the possible presence of multicollinearity in the independent variables by using the variance inflation factor. Serial correlation was tested through the use of the Durbin-Watson d-test. If these conditions existed, potentially compromising the model, corrections were made to help ensure the most reliable regression.

Limitations. This study addresses some of the limitations of several previous studies by using quarterly data for all variables and expanding the period studied back to 1926.3 Because dividend and earnings data are reported quarterly, models that use monthly data are less accurate than models that use quarterly data. Monthly data would normally be advantageous, but in this case, using monthly data would have led to a weaker model because from 1926 through the mid-1990s, a distinct pattern existed of dividends being paid in February, May, August, and November.

Past **financial** bubbles have shown that emotions can cause irrational pricing of assets, but measuring the effect emotions such as fear or greed have on securities prices was beyond the scope of this study.

Exhibit 1.

Exhibit 2.

Another limitation is that the study assumed that variables closely related to each other in the past are still closely related, whereas they may now be related differently or not at all. Some pundits believe we have entered a new era, but this has been stated many times before and rarely proved to be correct. Remember the "new era" exuberance of 1928-1929 and large-cap growth stocks in the early 1970s?

A further limitation of this study is that the use of the best models from past studies and further manipulation of them by adding new variables surely led to an overstated explanatory power. Although the original 11 independent variables were reduced to 10, this number is still substantial. Moreover, I used numerous independent variables in an effort to take into account everything that could help justify a high market P/E under current conditions. And some of the previous studies may also have made multiple attempts before publishing their final models.

Findings

The independent variables were found to have reasonably normal distributions. Many of the variables had relatively high positive serial correlations (that is, their values tended to remain above the mean for several observations and then below the mean for several observations). Such a pattern frequently occurs in macroeconomic data because that pattern reflects the nature of the business cycle; generally, several years of above-average growth are followed by a period of below-average growth. Because the T-bill and T-bond yield variables appeared to suffer from multicollinearity, the T-bill variable was discarded, and the T-bond yield serves as a proxy for both.

Table 2 gives the coefficients for the predictors regressed against four models-the models using P/E, E/P, E/P with four variables lagged, and the final E/P model (which used only significant variables). The P/E regression was run with the 10 independent variables (without T-bills); it resulted in an R^2 of 83.8 percent (adjusted R^2 of 83.0 percent) and an F-**value** of 99.98. Seven variables were statistically significant: S&P 500 earnings growth (EGroYoY), dividends (DivPayQ), dividends on S&P 500 stocks (DivYldQ), standard deviation of S&P 500 returns (SDoRtrn), total return of S&P 500 stocks (RtrnQ), inflation level (InflQtr), and the Fed P/E index (FedPEX). DivPayQ and DivYldQ, with direct and inverse coefficients, respectively, were by far the most powerful variables. Quarterly return ranked third and had the effect of greater RtrnQ increasing P/E. The Fed P/E index was fourth and had an unexpected negative sign. Next was volatility of returns; lower SDoRtrn indicated higher justifiable P/E.

The low Durbin-Watson d-statistic (1.24) indicates a possible serial correlation problem with the P/E regression. When I used current values for quarterly dividend yield of 0.3 percent (1.2 percent annually), dividend payout of 40 percent, quarterly return of 5 percent, standard deviation of 13 percent, quarterly inflation of 0.45 percent (1.8 percent annually), GDP growth of 3.5 percent, FedPEX of 16.67 (inverse of 6.0 percent, 10-year bond yield), bond yield of 6.0 percent, M2 growth of 5.5 percent, and year-over-year earnings growth of 7 percent, this model produced a justifiable P/E of 18.23.
Because Beaver and Morse, Cho, Zarowin, and Litzenberger and Rao (1971) surmised that E/P might produce a better linear regression with numerous macroeconomic variables, yielding a higher R^2, I also ran regressions using E/P as the dependent variable. Using all the variables, the model produced an R^2 of 88.6 percent (88.0 percent adjusted), an F-**value** of 150.08, and a DurbinWatson d-statistic of 1.80. All of these values are better than the previous best model, which used P/E with the same 10 variables. Thus, E/P does appear to produce an improved regression. When the same current observations were used as listed for the P/E model, the model produced a justifiable EiP of 0.0494 (P/E of 20.23). This higher P/E is somewhat closer to the current 30-35 level.

Next, lags of one and two quarters were applied to each variable in an effort to refine the model. Two-- quarter lags never helped the regression, but a onequarter lag enhanced the model when it was applied to four variables (SDoRtrn, BndYldQ, GDPQoQ, and EGroYoY). This model produced an R sup 2

of 89.0 percent (88.4 percent adjusted), an F-**value** of 154.97, and a Durbin-Watson d-statistic of 1.79. Thus, regression with a one-quarter lag is clearly an enhanced regression. The Durbin-Watson statistic (close to 2.0) indicates little, if any, serial correlation in the overall model. The explanatory power (R

sup 2

) and strength (F-**value**) of the last two models were improved.

Table 2.

On the one hand, obtaining explanatory power in the 88 percent range while including the extremely volatile periods of World War II and the Depression is remarkable. On the other hand, multiple modifications to the model, including the use of lagged variables (which have no strong theoretical basis), certainly increased the chances of obtaininga high R

sup 2

. This model predicted an E/P of 0.0490, corresponding to a P/E of 20.40. The best overall multiple-regression model, which used only the statistically significant predictor variables to explain E/P, is shown in the last column of Table 2. The final model was an E/P

This regression would predict a current E/P of 0.0437, which converts to a P/E of 22.86, still well below today's 30-35. Eight of the ten variables were shown to be significant; only money supply and standard deviation (of return) were not significant. The three most significant variables all had the expected sign. E/P decreased with higher dividend payout and trailing stock returns and increased with higher dividend yield. Earnings growth, GDP growth, inflation, and bond yield also had the expected effects. Only the Fed P/E index had an unexpected sign on its coefficient. With eight significant variables and an F-**value** greater than 190, this model is statistically significant.4

The ranking of variables was consistent among all three E/P regressions. DivYldQ was first, DivPayQ was second, RtrnQ was third, and FedPEX was fourth-just as in the P/E model. Inflation was the fifth most explanatory variable in all the E/P models.

Conclusions

The study reported here augmented past studies that were most similar to it-that is, time-series studies of broad equity markets or indexes. The Campbell and Shiller model used dividend yield, earnings growth, and inflation as the independent variables and used annual data for 1872-1997. Their model resulted in an R 2 of 64 percent. They stated that current valuations might be, in part, a result of supply and demand for equity investments. Loughlin's 1996 study found P/E to be dependent on expected earnings, dividend payout, and bond yields. Using quarterly data for 26 years

ending in 1993, his model produced a 49 percent R

sup 2

. The last similar study was my 1997 investigation that used GDP growth, inflation , and dividend payout with annual data for 196-1996. This model resulted in an R

sup 2

of 83.6 percent. The current study added several variables and increased the time span to 1926 through 1997, resulting in a new R

sup 2

of more than 88 percent.5 The addition of significant independent variables appears to have more than offset the effect of unstable relationships between variables in the 1926-55 period.

This study showed the significance of serveral multiple linear regression models that used P/E or E/P as the dependent variable. With explanatory power reaching more than 88 percent, the independent variables appear to have been selected with some justifiable basis. Clearly, numerous statistically significant determinats of P/E are available. All of the regressions exhibited explatory power (adjusted R

sup 2

) of 83 percent to more than 88 percent. Frequently, high R

sup 2

s are associated with studies of time-series variables, such as the S&P 500, as a function of GDP or money supply. This outcome is to be expected when the modeler is usning the actual values (as opposed to the change in values) of variables that all have to the change in valeues) of variables that all have long--term upward trends. In this study, quarterly percentage changes in marcroeconomic variables were used, so an adjusted R

sup 2
os greater than 80 percent with high F-values indicates a strong model indeed.6

Does the success of these models mean an investor can reliably predict future P/Es? No, it does not. Even if the prescient investor could reliably predict all of the independent variables, that investor could account for only 88.5 percent of P/E variation and forecast P/E within some confidence **interval**. The purpose of using the models in this study was to help determine whether the current P/E multiple is way out of line based on current or forecasted economic conditions. The market's current P/E of 30-35 appears to be considerably higher than is appropriate.

The average P/E over the past 72 years' broad range of economic conditions has been 14.4. And based on the regressions of this study, a P/E between 18 and 23 would seem to be justified by current economic conditions. Even the most forgiving (relatively high standard error of estimate) and optimistic (highest P/E) model (the E/P with lags) indicates little chance of a P /E of 35 or greater being justifiable in today's economy. Moreover, keep in mind that this study used ex post information and enjoyed the benefit of knowing what models worked well in earlier studies. Because information from past studies was used and other significant variables were added, this study is surely biased upward in its explanatory ability. Nevertheless, the most optimistic new model could not find justification for the current market P/E-even after accounting for the current low inflation and interest

rates, low dividend yield, high earnings growth, and high returns in this nearly ideal economy.

Does this finding mean that the multiples of 30 to 35 seen in late 1998 and early 1999 are a signal to flee the U.S. stock market? Not really, but it might be a signal to reduce allocations to equities. Of course, if in the aggregate investors substantially decreased equity allocations, a crash could occur. Let the investor beware.

Notes

1. As noted, Beaver and Morse used F/P for some of their regressions for the same reason.

2. This period was chosen because 1926 is as far back as comprehensive records are available for some variables. Note that many prior studies did not incorporate data from earlier than 1954.

3. Raw data were available monthly, quarterly, and annually.

4. This result is not surprising given that I took the best previous models and modified them by adding new important variables and experimenting with lags.

5. Using the same time frame as the 1997 study would probably have resulted in an even greater R2, but the intent here was to expand the model to include severe shocks to the U.S. economy, such as World War II and the Great Depression.

6. The remaining 12-17 percent of variation may be attributable to any number of factors, including consumer confidence, herd mentality, and such emotions as greed and fear.

Any additional facs may or may not be accurately measurable or statistically significant.

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I thank R. Peter DeWitt, Pam Kirby, Robert Kirby, Junsoo Lee, and James Xander for their guidance and editorial comments.

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Geographic Names: United States; US

Descriptors: Securities markets; Economic conditions; Economic impact; Economic theory; Regression analysis; Studies
Classification Codes: 9190 (CN=United States); 3400 (CN=Investment analysis & personal finance); 1130 (CN=Economic theory); 9130 (CN=Experimental/Theoretical)
Print Media ID: 23847

30/9/14 (Item 14 from file: 148)
14366302 Supplier Number: 80855510 (THIS IS THE FULL TEXT)
The use of value at risk by institutional investors.(analysis of risk management)(Statistical Data Included)

Simons, Katerina
New England Economic Review , 21(10)
Nov-Dec , 2000
Document Type: Statistical Data Included
ISSN: 0028-4726
Language: English
Record Type: Fulltext
Word Count: 5441 Line Count: 00450

Text:

Senior Economist, Federal Reserve Bank of Boston. The author wishes to thank Richard Kopcke for helpful comments. David schramm provided valuable research assistance.

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In recent years, risk management has been of growing interest to institutional investors, including pension funds, insurance companies, endowments, and foundations as well as the asset management firms that manage funds on their behalf. Traditionally, institutional investors, and particularly pension funds, have emphasized measuring and rewarding investment performance by their **portfolio** managers. In the past decade, however, many U.S. pension funds have significantly increased the complexity of their portfolios by broadening the menu of acceptable investments. These investments can include foreign securities, commodities, futures, swaps, options, and collateralized mortgage obligations. At the same time, well-publicized losses among pension funds, hedge funds, and municipalities have underlined the importance of risk management and measuring performance on a risk-adjusted basis.

One approach to risk management, known as **Value** at Risk (or VaR), has gained increasing acceptance in the last five years. However, institutional investors' quest for a VaR-based risk-management system has been hampered by several factors. One is a lack of generally accepted standards that would apply to them. Most work in the area of VaR-based risk measurement and standard-setting has been done at commercial and investment banks in conjunction with managing market risk. VaR originated on derivatives trading desks and then spread to other trading operations. The implementations of VaR developed at these institutions naturally reflected the needs and characteristics of their trading operations, such as very short time horizons, generally liquid securities, and market-neutral positions. In contrast, investment managers generally stay invested in the

market, can have illiquid securities in their portfolios, and hold positions for a long time.

Moreover, many risk-management systems developed for trading operations are expensive to implement and beyond the budget and manpower of smaller pension funds. Nevertheless, recent developments in web-based technologies, which application service providers use to make risk measurement available to clients over the Internet, hold promise of bringing affordable risk management to the cross-section of smaller institutional investors. This makes it important to explore the practical issues institutional investors have to consider while implementing a VaR-based risk management system.

VaR is a measure of risk based on a probability of loss and a specific time horizon in which this loss can be expected to occur. Bank regulators use VaR to set capital requirements for bank trading accounts because VaR models can be used to estimate the loss of capital due to market risk. Pension plans are generally concerned not with the loss of capital, but with under-performing their benchmarks. Pension plans distinguish between a long-term or strategic asset allocation, also known as the "policy **portfolio**," and a short-term or tactical asset allocation. The policy **portfolio** is typically aimed to match the plan's liabilities. The actual **portfolio**, which represents the tactical asset allocation, can differ from the policy **portfolio** because fund managers implement market views with the goal of outperforming the policy **portfolio**. Thus, the policy port-folio represents the benchmark against which the actual **portfolio** performance is measured. Because performance is measured against the benchmark, the risk shoul d be measured the same way. At the same time, for defined-benefit plans, VaR can represent the risk that assets fall below a certain target, in particular the risk that assets would be insufficient to fund the benefits due employees.

VaR has advantages as a risk measure for institutional investors. Specifically, it is based on the current **portfolio** composition rather than the **historical** return on the **portfolio**, and it can be aggregated across many asset classes. The more traditional risk measures used in investment management have one of these characteristics, but not both. For example, tracking error is a measure of the deviation of the **portfolio**'s **historical** return from the return on the benchmark index. It may not be useful if the current composition of the **portfolio** differs from the one that produced these **historical** returns. On the other hand, two traditional asset-specific measures, beta for stocks and duration for bonds, are based on the current **portfolio** composition. Beta measures the **portfolio**'s systematic risk, that is, the degree to which its return is correlated with the return on the market as a whole. Duration measures the sensitivity of a bond **portfolio** to changes in interest rates. The higher the duration, the more sensiti ve it is to changes in interest rates. These measures, while useful, cannot be combined to provide an overall measure of risk.

Thus, VaR is particularly useful to a pension plan sponsor that has a multi-asset-class **portfolio** and needs to measure its exposure to a variety of risk factors. VaR can measure the risk of stocks and bonds, commodities, foreign exchange, and structured products such as asset-backed securities and collateralized mortgage obligations (CMOs), as well as off-balance-sheet derivatives such as futures, forwards, swaps, and options. VaR is useful to plan sponsors who have their portfolios managed by a variety of external asset managers and need to compare their performance on a risk-adjusted basis.

A survey of major pension fund sponsors and several asset management firms by one consulting firm (Kerrigan 1999) found that the demand for **portfolio** managers to produce VaR reports comes both from the senior management of their firms and from clients. Sometimes clients specify the confidence **interval** and time horizons used to

calculate VaR. **Portfolio** managers report both absolute and relative VaR measures. VaR does not replace tracking error but is used along with it. The survey reports that institutional investors mostly use parametric VaR, unless they have options in the **portfolio**, in which case they also use simulations.

This article is organized as follows: Section I describes one proposed set of risk management standards. Section II introduces the concept of **Value** at Risk and describes the parametric VaR, the most common method of its calculation. Section III compares VaR to tracking error, a common measure of risk employed by institutional investors, showing that tracking error can be seen as a special case of **Value** at Risk. Section IV discusses the issues surrounding measures of risk-adjusted performance. Section V describes the major difficulties institutional investors may encounter when implementing VaR **analysis**. Section VI discusses some public policy implications of widespread VaR adoption.

I. Elements of Risk Management Standards for Institutional Investors

While no generally accepted standards exist for risk management and measurement for institutional investors, one major study, by the Risk Standards Working Group (1996), addressed many of the issues in general terms. The study formulated 20 risk standards, grouped into three categories of management, measurement, and oversight. A summary of the Working Group's guidelines that are related specifically to the measurement of risk follows:

Risk Measurement Guidelines of the Risk Standards Working Group

1. **Valuation** procedures

Readily priced instruments such as publicly traded securities, exchange-listed futures and options, and many over-the-counter derivatives should be priced daily.

Less readily priced instruments such as complex CMOs, exotic derivatives, and private placement notes should be priced as often as possible and at least weekly. For such instruments, the model and price mechanism must be made explicit so that they can be independently verified.

Non-readily priced assets such as real estate and private equity stakes should be valued as frequently as is feasible and whenever a material event occurs. For such instruments, the **valuation** method (such as theoretical model, appraisal, committee estimate, or single-dealer quote) should be made explicit to facilitate independent evaluation.

2. **Valuation** reconciliation, bid-offer adjustments, and overrides

Material discrepancies from different sources, such as managers and custodians, should be reconciled following established procedures at least monthly, or more frequently if material difference occurs.

3. Risk measurement and risk/return attribution **analysis**

Risk should be measured in the overall portfolios, individual portfolios, and each instrument. Return attribution **analysis** should be performed to determine the key **historical** drivers of returns on the portfolios. Risk attribution **analysis** should also be performed to determine the key sources of volatility of returns in the current or anticipated **portfolio**. For example, a risk attribution **analysis** of a U.S. bond **portfolio** might quantify duration, yield curve, convexity, and sector risk in absolute terms or relative to a benchmark. A risk attribution **analysis** of a U.S. equity **portfolio** might use a risk-factor model to quantify the various sources of absolute and benchmark-relative risk.

4. Risk-adjusted return measures

Investors should compare all managers on a risk-adjusted basis. By taking into account both risk and return, they will be able to better evaluate performance of two managers. Risk-adjusted measures also highlight instances in which a manager's outperformance is the result of incurring misunderstood, mispriced, unintended, or undisclosed risks.

5. Stress testing

Stress testing should be performed to ascertain how the aggregate **portfolio** and individual portfolios would behave under various market conditions. These include changes in key risk factors, correlations, and large market moves. Stress testing should be performed at least quarterly or whenever significant changes occur in market conditions or in the composition of the **portfolio**.

Stress tests should take into account all types of leverage and related cash flows, including such items as repurchase agreements, options, structured notes, and high-beta stocks, as well as instruments requiring initial and **valuation** margin requirements.

6. Back testing

Investors should back test all models and forecasts of expected risk, return, and correlations for instruments, asset classes, and strategies. Back tests evaluate how a model actually performed for a given period versus what was predicted.

7. Assessing model risk

Dependence on models and assumptions for **valuation**, risk measurement, and risk management should be evaluated and monitored. Important dimensions of model risk to analyze include the following:

* Data integrity (for example, curve construction, differing sources of data, representativeness and statistical significance of samples, the time of day data are extracted, data availability, and errors)
* Definition and certainty of future cash flows (formula-driven cash flows or flows that depend on an option)
* Formula or algorithm (Black-Scholes versus Hull and White for options **valuation**)
* Liquidity assumptions (length of time to liquidate and bid-ask spreads)
* Model parameter selection (choice of spreads, discount rates, scenario and stress-test parameters, probability **intervals**, time horizon, correlation assumptions).

II. Calculating **Value** at Risk

VaR answers the question, "Over a given period of time with a given probability, how much could the **value** of the **portfolio** decline?" If VaR equals a thousand dollars, and the probability is 1 percent, then one can say that the chance of losing one thousand dollars over the holding period is 1 in 100. One advantage of VaR is that it is an intuitively appealing measure of risk that can be easily conveyed to the firm's senior management.

The three main methods of calculating VaR are the parametric (or analytic, or variance-covariance) method, the **historical** method, and the Monte Carlo simulation. Detailed descriptions of these methods can be found in RiskMetrics Technical Document (Longerstaey and Zangari 1996), Simons (1997), and Duffie and Pan (1997). Briefly, parametric VaR assumes that the returns on the **portfolio** can be approximated by a normal distribution, and it draws on the properties of that distribution to calculate the probability of loss. Thus, it conveys the same information as the standard deviation, but on a different scale. Among the relevant properties of the normal distribution is that 67 percent of returns will fall within one standard deviation around the mean, while 33 percent will lie outside it. Since normal distributions are symmetric and we are concerned only with the loss (the left tail of the distribution), losses in excess of one standard deviation will occur 16.5 percent of the time. One minus the probability is referred to as the confidence level. Table 1 summarizes some common confidence levels that can be used for calculating parametric VaR.

Time Horizon

The time horizon used to calculate VaR should depend on the liquidity of the securities in the **portfolio** and how frequently they are traded. Less liquid securities call for a longer time horizon. The most common time horizons used by commercial and investment banks to

calculate VaRs of their trading rooms are one day, one week, and two weeks. The Basle Committee on Banking Supervision mandates that banks using VaR models to set aside capital for market risk of their trading operations use a holding period of two weeks and a confidence level of 99 percent. In contrast, institutional investors have long holding periods for investments, ranging from one month to as long as five years.

Long time horizons complicate VaR modeling, because the use of the daily data to estimate volatilities and correlations among assets may not be valid over these long time horizons. Moreover, a VaR estimate for a given time **interval** implies that the investor cannot or will not trade out of the position during this time. If "mid-course" corrections are possible, the VaR can overstate the probable losses when the investor takes conservative action. Also, using derivatives to hedge the **portfolio**, such as purchasing put options and other " **portfolio** insurance" techniques, complicates VaR calculations.

III. Comparing **Value** at Risk and Tracking Error

Traditionally, **portfolio** managers and institutional investors measure both risk and return relative to a benchmark. The commonly used benchmarks for measuring stock returns are the S&P 500 for stocks in general and large capitalization funds, the Wilshire 5000 and the Russell 3000 for the U.S. market in general, the Russell 2000 for small stocks, and the Morgan Stanley EAFE for international portfolios.

Tracking error is a measure of risk based on the standard deviation of **portfolio** returns relative to the chosen benchmark return. It is defined as the standard deviation of the excess return, that is, the difference between the return on a **portfolio** and the return on its benchmark. Unlike VaR, which is usually measured for shorter periods, tracking error is typically measured in terms of monthly returns. However, returns can be measured over a period of any length.

ER = (R.sub.p) - (R.sub.b)

TE = (Square root of (1/T*(Summation over ((((ER.sub.t) - ER).sup.2))))) (1)

In equation (1), (ER.sub.t) is the excess return of the **portfolio** over the benchmark return in period t, ER is the average excess return, TE is the tracking error, and T is the number of periods over which the tracking error is being calculated.

Unlike tracking error, which is measured in percent relative to the benchmark, VaR is usually measured as a dollar amount of loss that can occur with a given probability However, it is possible to calculate "tracking VaR," which is also measured relative to the benchmark. One can think of tracking VaR as measuring a loss in a hypothetical **portfolio** consisting of a long position in the actual **portfolio** being measured and a short position in its benchmark. Tracking VaR is usually expressed in terms of return, rather than an absolute amount of money the **portfolio** may lose.

Thus, the tracking error can be seen as a special case of tracking VaR where the confidence level and holding period are fixed-at 83.5 percent and one month, respectively. So, a tracking error of X percent means that a monthly underperformance greater than X percent relative to the benchmark can be expected to occur 16.5 percent of the time, or once every six months.

Instrument Mapping

For large investors with portfolios containing many securities, VaR calculations require vast quantities of data to construct the variance-covariance matrix of their returns. Thus, most users need some way of mapping of instruments into a smaller number of standard equivalents (commonly known as risk factors) for which data are available. For example, a very popular data set of volatilities and correlations is J. P. Morgan's RiskMetrics, which is free to the public, downloadable from the Internet, and updated daily. The data include a number of major currencies, interest rates, commodities, and equity indexes for major markets and countries.

An Example of VaR and Tracking Error Calculation

We will use an example of a U.S. equity mutual fund and find its parametric and **historical** VaRs and its tracking error. We first calculate the fund's daily return for 360 trading days as well as its daily excess return over the S&P 500, which is the customary benchmark for U.S. equity funds. The daily returns used were for the period between 5/11/1999 and 10/10/2000. Table 2 shows the fund's actual daily returns for selected days in column 2, the daily returns on the S&P 500 in column 3, and the excess return, which is the difference between them, in column 4. Average daily returns and standard deviations over the entire period are shown at the bottom of the table.

We can see from the last row in column 4 that the fund's daily tracking error, that is, the standard deviation of its excess return, is 0.98 percent. The fund's daily parametric VaR at the 99th percent confidence level is the standard deviation of its returns (which is equal to 1.24) multiplied by 2.33 (see Table 1), or 2.89 percent. This means, roughly speaking, that a negative daily return of 2.89 percent is expected to occur about 1 out of a 100 trading days.

One often wishes to calculate VaR for periods longer than one day, since it may not be possible to close a position in one day, especially if it is illiquid. If, in addition to normality, we assume that returns are serially independent, then the standard deviation of longer-period returns increases with the square root of time. A one-month (24 trading days) VaR is the daily VaR times (square root of (24)) (=4.9). Thus, if the returns can be approximated by the normal distribution, then VaR is simply a linear function of the standard deviation.

Selected values of absolute and tracking VaR (defined at the beginning of Section III) for one day and one month are shown in Table 3. They are calculated by multiplying the standard deviation of actual daily returns (1.24 for absolute VaR) or the standard deviation of excess return (0.98 for tracking VaR) by the appropriate numbers of standard deviations for the given confidence **interval** from Table 1, and then multiplying by (square root of (24)) in case of the monthly holding period. Note that the shaded cell, representing tracking VaR at the 83.5 percent confidence level, is also the conventional tracking error, or the monthly standard deviation of the fund's excess returns over its benchmark, the S&P 500.

IV. Risk-Adjusted Performance and Tracking Error

Both tracking error and tracking VaR show only how closely the returns on a given **portfolio** track the benchmark; they say nothing about performance. In fact, it is possible to underperform the benchmark quite dramatically while having a low tracking error or tracking VaR. This can be a serious weakness of the tracking error as a risk measure, since most **portfolio** managers would consider underperforming the benchmark to be perhaps their most significant risk.

Figure 1 illustrates how very different performance results can be associated with a similar tracking error. The figure shows daily values of $1 invested in three hypothetical portfolios: Fund A, Fund B, and a benchmark **portfolio**. These are simulated results that were produced by adding a **random** component drawn from a normal distribution to a different predetermined growth trend. The trend was 0.001 per day for Fund A, 0 for Fund B, and 0.0005 for the benchmark **portfolio**. As can be seen from the graph, over the course of one year (250 trading days), Fund A outperformed the benchmark by 15 percentage points, while Fund B underperformed it by 11. These large differences in performance occurred despite the fact that both funds managed to have an annualized tracking error of around 3 percent. This example shows that systematic trends in returns can have a powerful cumulative effect over the long-term investment time scales, even if the period-by-period tracking error is low.

This example also illustrates a serious difficulty with using simple measures based on standard deviations over long time horizons. Standard VaR methods usually assume that the expected return on the **portfolio**

is zero, or, at most, the risk-free rate. This is because trading portfolios are assumed to be market-neutral or held for such a short time that the expected return can be ignored. For measuring a long-term absolute VaR of an investment **portfolio**, it can make sense to incorporate an estimate of expected return on the asset. However, doing so is problematic for tracking error or tracking VaR that measures underperformance relative to the benchmark, because there really is no such thing as "expected" underperformance. If the manager of our hypothetical Fund B had known that the **portfolio** would underperform the benchmark by 11 percent, he would not have put on these positions in the first place! On the other hand, it can be quite tempting for a **portfolio** manager to incorporate an expected outperformance re lative to the benchmark into VaR. However, the majority of active managers regularly underperform their benchmarks, so doing so may be an unwarranted underestimation of risk.

Despite the fact that similar tracking errors or tracking VaRs can accompany large differences in returns, they can provide important information for adjusting performance for risk. This can be useful to a pension plan sponsor that is choosing between two or more funds representing the same asset class for inclusion in the plan. The plan sponsor could simply choose the fund that had the highest return relative to the benchmark. However, the fund may have achieved its high return by taking higher risk, not through any particular skill of its manager. Therefore, the plan sponsor may wish to make the selection on the basis of a risk-adjusted measure. Tracking error can be used for this purpose, to calculate the measure of risk-adjusted performance known as the Sharpe ratio (Sharpe 1966). Using the same notation as in equation 1, the Sharpe ratio can be expressed as follows:

Sharpe Ratio = ER/TE. (2)

The investment with the higher Sharpe ratio is preferable because it provides a higher return per unit of risk. Several points should be made about the Sharpe ratio. The same benchmark must be used for all the portfolios being compared; otherwise the comparison will be misleading. In comparing funds that would normally use different benchmarks, such as a bond fund and a stock fund, the Sharpe ratio would typically use a sort of "universal benchmark," namely a return on a risk-free investment such as Treasury bills. In this case, the Sharpe ratio is calculated as the expected excess return over the risk-free rate divided by the standard deviation of the excess return. Lastly, unless the returns of the funds are perfectly correlated, one can usually achieve a higher risk-adjusted return through a combination of available funds. However, a plan sponsor can only have a limited number of funds in the plan, so in practice the sponsor will often have to forgo making such a combination. In this case, however, the opt imal combination will still have a higher Sharpe ratio than any of the individual funds, so the principle of choosing the higher Sharpe ratio still holds.

V. Difficulties with VAR Implementations

One of the most serious and well-known shortcomings of parametric VaR is that it underestimates the frequency of "extreme events," such as outcomes several standard deviations away from the mean. This is because asset return distributions exhibit "fat tails," meaning that more of the outcomes are located in the tails rather than toward the center of the distribution.

Using the **historical** returns for the fund in the example above, we can compare the probable losses implied by the normal distribution to the actual size and frequency of losses that did, in fact, occur. The frequency distribution of the fund's returns is pictured in Figure 2 with the normal curve superimposed on it. We see that the 95th percentile loss was 1.72 percent, better than the 2.05 percent daily VaR implied by the normal distribution. For the 99th percentile, the actual loss was 2.61 percent, also better than the 99th confidence level VaR of 2.89 percent. So far, parametric VaR seems to hold up well in this example,

being more conservative than the actual outcomes. However, this impression is misleading. The normal distribution assigns virtually zero probability to events that are greater than 3 standard deviations. In fact, three events in our time series represented losses that were 4.5 standard deviations away from the mean, including a 12 percent loss which is a 9-standard-deviations event. Since the main objective of risk management models is to measure losses in the tails, this is a serious shortcoming.

The degree of "fat-tailness" of a distribution can be measured by kurtosis, which is defined as the fourth moment of the distribution (that is, the mean to the power of four) divided by the square of the variance. Thus, if r_i is the return on day i and σ^2 is the variance, kurtosis is defined as follows:

$$k = \sum_{i} r_i^4 / n\sigma^4 \quad (3)$$

The normal distribution has a kurtosis of 3. Any distribution that has a kurtosis greater than 3 is said to be leptokurtotic, that is, it has a lower central "hump" and fatter "tails" than the normal distribution. Our sample of mutual fund returns has a kurtosis of 25, indicating a rather high degree of leptokurtosis.

The fat tails of asset return distributions have elicited alternative approaches to parametric VaR. One is to simply use the percentiles of the actual **historical** returns on the **portfolio** to calculate VaR, the way we have done in this example. While this approach completely avoids the issue of choosing a distribution of asset returns, its applicability in practice is limited. In our example, we have used the returns on the actual **portfolio** for simplicity. In practice, one is generally interested in predicting the variance of the **portfolio** on the basis of its current composition, not its own **historical** returns, which may not reflect its current composition. Thus, one is interested in calculating VaR on the basis of the prospective variances and covariances of the instruments that are currently included in the **portfolio**, if these are available. (Even then, the variances and covariances of the risk factors may not stay constant for long because of structural shifts in the market, changes in fiscal or monetary pol icy, tax treatment of various assets, and other changes.) Unfortunately, this information often can be difficult or even impossible to assess. This is the reason why parametric VaR is often used instead of **historical** VaR.

To correct for the weaknesses of parametric VaR, or to test the consequences of changing composition of the **portfolio**, one can employ stress tests and scenario simulations. Such simulations can be useful to test the **portfolio** for hypothetical future events, such as increases in oil prices or an inflation surprise, and for the extreme effects of **financial** crises that occurred in the past, such as the culmination of the Asian crisis and Russian crisis in August 1998. It is not always clear, however, which scenarios should be tested for particular portfolios and how to interpret the results, since the probabilities that these scenarios will actually occur are unknown. It is also possible to model fat-tailed distributions explicitly. Approaches range from using a mixture of normals approach to stochastic volatility (see Simons 1997).

It should be noted that coping with fat-tail distributions is not unique to institutional investors. The problem of fat-tailed returns is a major issue of VaR modeling that banks' trading desks have been struggling with for years. It can even be argued that the longer-term perspective of institutional investors makes these short-term market swings less important to them than to investment and commercial banks, to the extent that asset prices exhibit mean reversion.

VI. Policy Implications

VaR has become art accepted standard in the banking industry and it forms the basis of bank capital requirements for market risk. VaR adoption has been slower in the investment management industry, but as demand grows and consensus about the standards emerges, its use can be expected to

accelerate. This will be a mixed blessing, as VaR has a number of serious limitations. It is based on volatilities and correlations that can work in normal market conditions but break down in times of market crises. Factors that exhibit low levels of correlation during normal market conditions can become highly correlated at times of high volatility. In such cases, the **value** of diversification across markets can be greatly reduced.
Thus, VaR can understate potential losses during market turbulence and instill a false sense of security. Nevertheless, VaR can be useful for those organizations that understand its limitations and use stress testing to gauge their vulnerabilities to "tail events."

There is another, more subtle, risk to the widespread adoption of VaR. During periods of turmoil, inefficient or illiquid markets could be destabilized if many market participants have rigid rules about exceeding VaR limits. That is because the VaR of a **portfolio** can change drastically as a result of changing market conditions, even if **portfolio** compositions do not change. If managers are given a mandate to keep VaR below a certain level, they will have no choice but to sell instruments causing high VaR at the moment. Used in this way, VaR can be seen as a type of dynamic hedging. As it gains worldwide acceptance, this type of VaR management has the potential to drive down asset prices and increase volatilities in thin or illiquid markets if enough market participants act together because they have similar positions and use similar models.

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(Figure 1 omitted)

(Figure 2 omitted)

Table 1

VaR Calculation for Various Confidence Levels

One-tail test based on the normal distribution

Confidence Level (percent)	Number of Standard Deviations
83.5	1.00
95.0	1.65
97.5	1.96
99.0	2.33
99.9	2.56

Table 2

Daily Returns on a Stock Fund and Its Benchmark

Percent

Date	Fund	S&P 500	Excess Return

05/11/1999	-.48	1.14	-1.62
05/12/1999	.00	.62	-.62
05/13/1999	-.58	.26	-.84
	...	...	...
10/06/2000	-1.72	-1.90	.18
10/09/2000	-.06	-.49	.43
10/10/2000	-.06	-1.07	1.01
Average daily return	-.04	.02	-.06
Standard deviation	1.24	1.23	.98

Table 3

Value at Risk and Tracking Error Calculations

Percent

Confidence Level	Absolute VaR 1 day	Absolute VaR 1 month	Tracking VaR 1 day	Tracking VaR 1 month
83.5	1.24	6.07	.98	4.78
95.0	2.05	10.02	1.61	7.89
99.0	2.89	14.15	2.27	11.14

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Industry Codes/Names: BUSN Any type of business; REG Business, Regional
Descriptors: Risk management--Analysis; Investment companies-- Analysis
Geographic Codes: 1USA United States
Product/Industry Names: 6799000 (Investors NEC); 9915300 (Asset & Risk Management)
Product/Industry Names: 6799 Investors, not elsewhere classified
NAICS Codes: 52599 Other Financial Vehicles
File Segment: AI File 88

30/9/15 (Item 15 from file: 148)
13392655 Supplier Number: 68653449 (THIS IS THE FULL TEXT)

USING CONSUMPTION AND ASSET RETURN DATA TO ESTIMATE FARMERS' TIME PREFERENCES AND RISK ATTITUDES.

LENCE, SERGIO H.
American Journal of Agricultural Economics , 82 , 4 , 934
Nov , 2000
ISSN: 0002-9092
Language: English
Record Type: Fulltext
Word Count: 7841 Line Count: 00673

Text:

The generalized expected utility model is fitted to U.S. farm data to estimate farm operator's time preferences and risk attitudes. The estimated farmer's utility parameters are quite "reasonable" and exhibit high accuracy. The forward-looking expected utility model is soundly rejected in favor of the generalized expected utility paradigm. Importantly, the

generalized expected utility model is also found to fit the data better than the myopic model typically used to study agricultural production under risk. Finally. U.S. farmers' relative aversion to risk appears to have diminished significantly over time.

Key words: discount rate, intertemporal substitution, risk aversion, time preferences.

To a great extent, agricultural policies have **historically** focused on stabilization and investment issues. For example, target prices, subsidized crop insurance, and more recently, revenue assurance are all policies aimed at stabilizing farm income, and ultimately at reducing the risks faced by farmers. Policies aimed at promoting farm investment have included, among others, creating the Farm Credit System and Farmer Mac, offering subsidized interest rates and credit guarantees through the Farmers Home Administration, and providing investment tax breaks.

The emphasis of agricultural policies on stabilization and investment programs is far from arbitrary. Rather, such emphasis merely reflects two major long-standing and interrelated economic problems: (a) how to best allocate resources in the presence of risk, and (b) how to best allocate resources across time. Not surprisingly, there is a huge literature addressing the role of risk in production **analysis**. This avenue of research has built upon Sandmo's pioneering work. Given the central role played by risk attitudes, some studies have specifically focused on the estimation of farmers' risk preferences (e.g., Antle; Chavas and Holt; Saha, Shumway, and Talpaz).

Gaining a better understanding of how farmers make intertemporal allocations is also highly relevant. Such allocations are governed by two fundamental characteristics of farmers' utilities; namely, the rate of time preference (RTP) and the elasticity of intertemporal substitution (EIS). RTP indicates by how much agents discount the utility of consuming in the next period relative to the utility of consuming now. EIS, on the other hand, shows the extent to which agents are willing to substitute consumption intertemporally in response to changes in relative prices across time. Improved knowledge of these attributes of farmers' preferences is essential to generate better predictions of the likely effect of alternative policies, (1) as well as to provide a better understanding of agricultural asset prices in equilibrium, among other fundamental economic concerns. Despite the importance of these issues, the literature explicitly addressing RTP and EIS in agriculture is scarce, especially when compared with the hu ge number of studies dealing with agricultural risk. (2)

The main contributions of the present study to the agricultural economics literature are fivefold. First, a novel data set is employed to perform the simultaneous estimation of U.S. farmers' RTP, EIS, and risk attitudes relying on the generalized expected utility (GEU) model developed by Epstein and Zin (1989, 1991) and Weil (1990). The data set is built using aggregate data for the farm sector and, given its potential usefulness, its construction is documented in the Appendix. Second, the GEU model and the forward-looking expected utility models are compared theoretically with the myopic expected utility model typically used to analyze agricultural production under risk. Third, the myopic model's empirical performance is explored vis-a-vis that of the GEU model. Fourth, the stability of farmers' preferences over time is analyzed. Finally, inferences about the behavior of agricultural asset prices and about farmers' consumption and savings, among other issues, are drawn based on the estimated utility parameters.

The major results can be summarized as follows. First, the GEU model fits the data quite well, and the utility parameters are estimated with high accuracy. These are important findings, as previous studies using much more aggregate data have found the empirical performance of the theoretical

model to be disappointing, and their parameter estimates usually exhibit very low accuracy. Second, the estimated farmers' utility parameters are quite "reasonable," in the sense of being consistent with the prior beliefs of many economists. Third, the forward-looking expected utility model is soundly rejected in favor of the GEU paradigm. Fourth, the GEU model is also found to fit the data better than the myopic model typically used to study agricultural production under risk. Finally, farmers' relative aversion to risk appears to have diminished significantly over time.

The study proceeds as follows. First, the GEU model is presented. Then, the relevance of knowing the magnitudes of RTP, EIS, and the coefficient of relative risk aversion (CRR) for policy **analysis** is discussed, along with the connection between the standard model used in production risk **analysis** and the GEU model. Estimation methods and data are described next. This section is followed by the presentation of the results and their corresponding discussion. The final section consists of concluding remarks.

Theoretical Model

The empirical **analysis** is based on the GEU model developed independently by Epstein and Zin (1989, 1991) and Weil (1990). In the interest of space, the GEU model is only briefly outlined here. For thorough discussions and derivations, interested readers are referred to Epstein and Zin (1989, 1991), Weil (1990), Altug and Labadie, and Campbell.

According to the GEU model, the agent's objective function is to maximize the following lifetime utility function (assuming 0 (less than) (beta) (less than) 1, 0 (neq) (rho) (less than) 1, and 0 (neq) (alpha) (less than) 1) (3) subject to a budget constraint:

(1) (max.sub.(c.sub.t)(a.sub.1),t,...,(a.sub.l)t) (U.sub.t)
= ({(1 - (beta))((c.sup.(rho)).sub.t) + (beta)(((E.sub.t)(((U.sup.(alpha)).sub.t+1))).sup.(rho)/(alpha))}.sup .1/(rho))

s.t. (C.sub.t) + (((sigma).sup.I).sub.i=1)(a.sub.i,t) (less than or equal to) (W.sub.t) and (W.sub.t+1) = (((sigma).sup.I).sub.i=1)(1+(r.sub.i,t+1))(a.sub.i),t,

where (c.sub.t) denotes consumption at time t, (a.sub.i,t) is the amount invested in asset i, (E.sub.t)(*) represents the expectation operator conditional on information available at date t, (W.sub.t) denotes wealth, (r.sub.i, t+1) is the net return (realized at t + 1) per dollar invested in the ith asset at date t, and (beta) (rho), and (alpha) are parameters characterizing the agent's utility function. Parameter (beta) is the discount factor per period. By consuming at t + 1, the agent only gets a fraction (beta) of the utility that he/she would get by consuming an equal amount at t. The discount factor implicitly defines the agent's RTP, which is given by RTP = 1/(beta) - 1 (greater than) 0 for 0 (less than) (beta) (less than) 1. Attitudes toward risk and preferences toward intertemporal substitution are parameterized independently by (rho) and (alpha), respectively. More specifically, CRR = 1 - (alpha) and EIS = 1/(1 - (rho)).

In equation (1), utility is defined recursively over consumption. In the presence of uncertainty about future asset returns, next period's utility is **random** (denoted by "(sim)"). Hence, the agent is assumed to consider the expected **value** of next period's utility in making his/her current consumption and investment decisions. According to the budget constraint, wealth at time t may be used to consume ((c.sub.t)) and to invest in a **portfolio** of I assets. (4) Wealth at t + 1 ((W.sub.t+1)) consists of the sum of gross returns on time-t investments.

Model (1) is referred to as GEU because letting (alpha) = (rho) yields the forward-looking expected (power) utility specification traditionally used by researchers in **finance** (e.g., Merton, Lucas, Breeden, Kocherlakota and references therein), macroeconomics (e.g., Hall 1978), and intertemporal consumption **analysis** (e.g., Deaton and references therein), among other fields in economics:

(2) (max.sub.(c.sub.t),(a.sub.1,t),...,(a.sub.1,t)) (U.sub.t) = (1 - (beta)) (E.sub.t) (((c.sup.(alpha)).sub.t) + (((sigma).sup.(infinity)).sub.s=1) ((beta).sup.s) ((c.sup.-(alpha)).sub.t+s))

s.t. (c.sub.t) + (((sigma).sup.I).sub.i=1) (a.sub.i), t (less than or equal to) (W.sub.t).

However, equation (1) is also often referred to as the "non-expected utility" model (e.g., Weil 1990, Altug and Labadie) because, unlike the expected utility model (2), the utility index in equation (1) is generally nonlinear in the probabilities.

Upon manipulation, and without loss of generality, the I + 1 first order necessary conditions (or Euler equations) corresponding to equation (1) may be expressed as follows:

(3) (E.sub.t)((d.sub.t+1)(1+(r.sub.i,t+1))-1)= 0, i = 1, ... , I,

(4) (E.sub.t)((d.sub.t+1)(1+(r.sub.0,t+1))-1)/(gamma) = 0,

where (d.sub.t+1) (equivalent) ((beta).sup.(gamma))(((c.sub.t+1)/(c.sub.t)).sup.(gamma)((rho)-1)) ((1+(r.sub.0,t+1)).sup.(gamma)-1) is known as the stochastic discount factor, pricing kernel or intertemporal marginal rate of substitution (Altug and Labadie, p. 11), (gamma) (equivalent) (alpha)/(rho), and (r.sub.0,t+1) (equivalent) ((sigma).sub.i)(r.sub.i,t+1) (a.sub.i,t)/((sigma).sub.i)(a.sub.i,t) is the net return per dollar invested in the optimal **portfolio**. Because of the budget constraint, only I of the I+1 equations in system (3)-(4) are independent. This system is very important for present purposes, as econometric estimation of the utility parameters relies upon the empirical counterparts of equations (3)-(4).

In general, the stochastic discount factor ((d.sub.t+1)) is a **random** variable that depends on the agent's risk and intertemporal preferences. It is the ratio of the marginal utility of next-period's consumption to the marginal utility of current consumption, thereby reflecting the marginal benefit-to-cost ratio of substituting future consumption for current consumption. Hence, equation (4) simply states that the marginal cost of giving up one unit of consumption today must equal its expected marginal benefit, after "correcting" the latter for the rate of return on the optimal **portfolio**. This "correction" is required because giving up one unit of consumption today allows not for one but for (1 + (r.sub.0,t+1) units of consumption next period, as the dollar saved by foregoing present consumption is invested in the optimal **portfolio** until next period. Further, according to equation (3), at the optimum the last dollar invested in asset i must yield an expected gross rate of return equal to one, after "correcting " asset i's rate of return by the marginal benefit-to-cost ratio induced by diverting that last dollar from current consumption to asset i.

Why Is It Important to Quantify RTP, EIS, and CRR?

Before turning to the empirical **analysis**, it is appropriate to briefly discuss (a) the relevance of quantifying utility parameters RTP (=1/(beta) - 1), EIS (=1/(1 - (rho))), and CRR (=1 - (alpha)), and (b) the connection between forward-looking models (1) and (2) with the myopic model typically used in agricultural production **analysis** under risk. To motivate the discussion, the role of RTP and EIS on intertemporal choice is highlighted first. (5)

Implications of RTP and FIS for Intertemporal Behavior

To isolate the effects of RTP and EIS from those of CRR, certainty is assumed so that expected values are identical to realized values. Consider first the case of perfect substitutability across time (i.e., EIS (right arrow) (infinity) (right arrow) (rho) (right arrow) 1 from below). Then, the utility function in equation (1) simplifies to (U.sub.t) = (1 - (beta)) ((sigma).sub.s)(greater than or equal to) 0 ((beta).sup.s)(C.sub.t+s). If, in addition, myopic behavior is assumed, implying consumption at t + 2 and beyond yields no utility, the graph of the indifference curve for consumption at times t and t + 1 consists of a

straight line with a slope equal to (minus) 1/(beta) = 1 + RTP, as in figure 1. Consuming one unit at t + 1 yields only a fraction (beta) of the utility obtained by consuming the same unit one period earlier. Other things equal, agents with smaller (beta) (or greater RTP) will display a greater propensity to consume now rather than in the future, and will therefore tend to save (i.e., invest) less.

In this purposefully simplistic scenario all assets are risk-free. Therefore, in market equilibrium there can be effectively only one asset, which earns a risk-free net rate of return of (r.sub.rf,t+1). (6) The budget constraint in equation (1) can then be expressed as

(5) (c.sub.t) + 1/1 + (r.sub.rf,t+1) (c.sub.t+1) + 1/1 + (r.sub.rf,t+1)
x (a.sub.rf,t+1) (less than or equal to) (W.sub.t).

As shown in figure 1, equation (5) consists of a straight line with slope equal to (minus) (1 + (r.sub.rf,t+1)) in consumption space. In essence, 1/(1 + (r.sub.rf,t+1) is the price of future consumption relative to the price of current consumption. Given that both the indifference curve and the budget constraint are linear, the solution to this optimal consumption problem is of the bang-bang type. Figure 1 illustrates that agents consume nothing now and invest as much as possible in the risk-free asset (i.e., (c.sub.t) = 0, (a.sub.rf,t+1) = (W.sub.t) (greater than) 0) to increase future consumption ((c.sub.t+1) (greater than) 0) if (r.sub.rf,t+1) (greater than) RTP. In contrast, if (r.sub.rf,t+1) (less than) RTP agents invest nothing (or, if possible, borrow) to consume as much as possible now (i.e., (c.sub.t) = (W.sub.t), (a.sub.rf,t+1) = 0), and consume nothing in the future ((c.sub.t+1) = 0). That is, for a given interest rate, (r.sub.rf,t+1), the key determinant of agents' consumption-investment decisions is their RTP.

RTP has implications for general equilibrium as well. To see this in a trivial scenario, assume that in the economy under **analysis** all agents have identical RTP--albeit possibly different wealth. It then follows that the equilibrium risk-free interest rate must be (r.sub.rf,t+1) = RTP. Otherwise, everybody would want to consume either nothing now or nothing in the future, thereby contradicting the equilibrium condition that aggregate consumption be equal to aggregate wealth in each period.

Consider now the opposite case of no intertemporal substitutability (i.e., EIS = 0 (right arrow) (rho) (right arrow) - (infinity)), while maintaining the myopic assumption. The resulting utility is of the Leontief type, (U.sub.t) = min((c.sub.t), (beta)(c.sub.t+1)), as illustrated in figure 2. Due to the lack of substitutability, agents always consume in the fixed ratio (c.sub.t+1)/(c.sub.t) = (beta) = 1/(1+RTP) regardless of the market interest rate (r.sub.rf,t+1). This implies that, irrespective of the market interest rate (r.sub.rf,t+1), agents save (borrow) if the ratio of current expendable income to future expendable income is greater (less) than (beta) = 1/(1+RTP). The saving scenario is illustrated in figure 2. Due to consumption's lack of response to changes in the interest rate, in equilibrium the interest rate is not uniquely determined. Hence, it need not be the case that be (r.sub.rf,t+1) = RTP.

In summary, knowing agents' RTP and EIS is essential to understanding their investment/borrowing and intertemporal consumption decisions, as well as to explain the behavior of interest rates (and implicitly, assets' rates of return) in market equilibrium.

Relation with the Standard Approach Used in Production **Analysis** Under Risk

Perhaps the most distinctive characteristic of the standard approach to analyzing agricultural production under risk is that it implicitly assumes myopic or static (as opposed to forward-looking) behavior. Following the pioneering work of Sandmo, the vast majority of such studies assume that agents maximize the expected utility of next period's profits (((pi).sub.t+1) (equivalent) (((sigma).sup.I).sub.i=1) (r.sub.i,t+1)(a.sub.i,t)) or, equivalently, the expected utility of next period's wealth ((W.sub.t+1) = ((pi).sub.t+1) + (((sigma).sup.I).sub.i=1)

(a.sub.i,t)): (7)

(6) (max.sub.(a.sub.1,t,...,)(a.sub.1,t)) (V.sub.t) = (E.sub.t)(v(((pi).sub.t+1)))

= (E.sub.t)(w((W.sub.t+1))) s.t.

x (((sigma).sup.I).sub.i=1) (a.sub.i,t) (less than or equal to) (K.sub.t),

where (K.sub.t) represents the funds available for investment at t. Consumption at t ((c.sub.t)) does not appear in equation (6) because it is (implicitly) subsumed in (K.sub.t). That is, (K.sub.t) denotes funds left for investment after current consumption.

As shown by Lence and Hayes, equation (6) is myopic because agents completely disregard what happens after the next period (i.e., after t + 1). One potential justification for using the myopic model (6) instead of the forward-looking model (1) is that production **analysis** under risk is not concerned with saving-consumption decisions. However, Lence and Hayes showed that forward-looking production decisions may be significantly different from their myopic counterparts. Ultimately, whether equation (6) explains actual behavior better than equation (1) or vice versa is an empirical matter. Hence, it is important to investigate which of the competing models (if any) is favored by the data. Another reason for comparing the empirical performance of equations (6) and (1) is that the former exhibits changing time attitudes, which Barry, Robison, and Nartea hypothesize to be a plausible description of farmers' time preferences. More specifically, equation (6) implies that RTP = (infinity) for consumption at t + 2 and beyond.

The parallel between equation (6) and the GEU model (1) is easiest to trace for the power utility case w((W.sub.t+1)) = ((W.sup.(alpha)).sub.t+1). In this instance, after a little manipulation the I Euler equations corresponding to equation (6) may be expressed as follows:

(7) (E.sub.t)(((1 + (r.sub.0, t+1)).sup.(alpha)-1) ((r.sub.i, t+1)) - (r.sub.0, t+1)))

= 0, i = 1,..., I,

where ((1 + (r.sub.0, t+1)).sup.(alpha)-1) is a **random** variable proportional to the myopic stochastic discount factor. Only I - 1 of the equations in system (7) are independent. The analogous system for the GEU model is equation (8), which may be obtained by rearranging equations (3)-(4):

(8) (E.sub.t)((((c.sub.t+1)/(c.sub.t)).sup.(gamma)((rho)-1)) ((1 + (r.sub.0, t+1)).sup.(gamma)-1)

x ((r.sub.i, t+1) - (r.sub.0, t+1))) + 0,

i = 1,..., I.

Clearly, equation (8) nests equation (7), as the latter may be obtained from the former by letting (rho) (right arrow) 1 ((alpha) (gamma) = (alpha)/(rho) = (alpha)). Despite this, the GEU model does not nest the myopic model because the former involves the additional Euler equation (4), which allows one to identify the GEU stochastic discount factor (d.sub.t+1). In contrast, the myopic discount factor is not identified. From equation (7), one can only infer that the myopic discount factor is proportional to ((1 + (r.sub.0, t+1)).sup.(alpha)-1), and that the proportion is non-stochastic conditional on information at t. To identify the myopic stochastic discount factor it is necessary to introduce current consumption ((c.sub.t)) explicitly in equation (6). This implies that the unidentifiable portion of the myopic stochastic discount factor is a function of agents' RTP and EIS. This is the main reason why neither RTP nor EIS are addressed in production **analysis** under risk.

Model (1) is more restrictive than model (6) because the former requires the stochastic discount factor to be (d.sub.t+1) (equivalent) ((beta).sup.(gamma)) (((c.sub.t+1)/(c.sub.t)).sup.(gamma)((rho)-1)) ((1 + (r.sub.0, t+1)).sup.(gamma)-1), whereas the latter only requires the stochastic discount factor to be proportional to ((1 + (r.sub.0, t+1)).sup.(gamma)-1). But at the same time, equation (1) is less

restrictive than equation (6) in that the stochastic portion of the GEU factor ((((c.sub.t+1)/(c.sub.t)).sup.(gamma)((rho)-1)) ((1 + (r.sub.0, t+1)).sup.(gamma)-1)) nests the stochastic portion of the myopic factor (((1 + (r.sub.0, t+1)).sup.(alpha)-l)). Importantly, this reveals that the fundamental difference between forward-looking and myopic behavior is that the former accounts for the impact of stochastic future consumption ((c.sub.t+1)) on current decisions.

To summarize, it is impossible to perform a simple nested test of the GEU model versus the myopic model because neither one nests the other. However, one may still be able to make some inferences about their relative empirical performance by comparing how well they fit the same data set(s).

Estimation Methods and Data

Hansen's generalized method of moments (GMM) is the typical method used to estimate Euler equations like (3)-(4) directly. Useful references for the theory underlying GMM include Hansen, Davidson and Mackinnon (ch. 17), and Ogaki. Altug and Labadie (ch. 3) and Campbell, Lo, and MacKinlay discuss GMM in the context of Euler equation estimation, and provide numerous references to specific applications, as well. Estimation is performed using the GMM procedure (with the "HET" option) in the econometric package TSP 4.4.

The construction of the consumption and asset return data employed in the econometric estimation is described in the Appendix. The consumption series ((c.sub.t)) used is real withdrawals per farm operator ((RWFO.sub.t)). (8) The basic data used to calculate RWFO are the farm sector's income statements and balance sheets published by the U.S. Department of Agriculture (USDA). The method employed follows the basic concepts introduced by Penson, Lins, and Irwin and used recently by Erickson, but with some modifications to yield a series corresponding to farm operators only. Such modifications are needed because the farm sector's s income statements refer to operator data, whereas the farm sector's balance sheets incorporate data for both operators and landlords (Penson). The data span the period 1934 (when data collection about farm operators' off-farm income began) through 1994, for a total of sixty one annual observations.

Two net rate of return series ((r.sub.i, t+1)) are employed; namely, real net rate of return to operator-owned farm real estate ((RRRE.sub.t+1)) and real net rate of return to operator's farm equity ((RROE.sub.t+1)). The RRRE series is chosen because it captures the rate of return of an important portion of farm assets, and is less prone to the problem of errors in measurement than the rates of returns on less aggregated asset categories. Operator's farm equity is the **value** of a farmer's asset **portfolio**; hence, RROE represents (r.sub.o, t+1).

Instrumental variables are needed for GMM. The most obvious instruments are the lagged values of consumption and returns. However, measurement errors and other data problems may lead to spurious results when using such instruments (Ferson and Constantinides). For this reason, it is better to use instruments other than lagged consumption and returns. To provide powerful tests of the Euler equation restrictions, instruments should be "predetermined" (i.e., known at time t), (9) highly correlated with date t + 1 consumption growth and rates of returns, and not too numerous (Davidson and Mackinnon, ch. 17). The instruments listed in table 1 satisfy such criteria. For example, regressions of ((RWFO.sub.t+1)/(RWFO.sub.t)), (RRRE.sub.t+1), and (RROE.sub.t+1) on the set of instrumental variables listed in table 1 have (R.sup.2)s of 0.348, 0.368, and 0.386, respectively. As a comparison, regressing ((RWFO.sub.t+1)/(RWFO.sub.t)), (RRRE.sub.t+1), and (RROE.sub.t+1) on their own lagged values yields (R.sup.2)s of 0.037, 0.378, and 0.380, respectively. (10) Following standard practice, all of the instrumental variables in table 1 are ratios rather than levels, to circumvent the problem of nonstationarity (Ogaki).

Results and Discussion

Results from GMM estimation of the GEU model are summarized in table

2. The top row contains the results obtained by using data for the entire period 1936-94, whereas the second and third rows display the results corresponding to the subperiods 1936-64 and 1966-94, respectively. It must be noted that, although the theoretical model requires that 0 (less than) (beta) (less than) 1 and (rho) (less than) 1, these restrictions were not imposed for estimation purposes.

Regarding the entire 1936-94 period, the test of overidentifying restrictions equals ((X.sup.12).sub.11), = 17.22 which a has p-**value** of 0.10. Hence, there is not enough evidence to reject the GEU model at the standard 5% significance level. Compared to most studies using GMM estimation of Euler equations (e.g., Campbell, Lo, and MacKinlay and references therein), all of the parameter estimates exhibit unusual precision (i.e., their associated standard errors are very small). More importantly, the point estimates satisfy the theoretical restrictions of the GEU model (i.e., 0 (less than) (beta) (less than) 1 and (rho) (less than) 1).

The point estimate of the discount factor (beta) = 0.9616 is quite "reasonable," in that it conforms to values often assumed in the literature. A simple testable hypothesis concerning the discount factor is whether farmers do discount the utility of future consumption. In this regard, the null hypothesis (H.sub.0): (beta) (greater than or equal to) 1 is soundly rejected in favor of the alternative (H.sub.A): (beta) (less than) 1, because the 95% confidence **interval** for (beta) is (0.9512, 0.9720). Therefore, the 95% confidence **interval** for (beta) is (0.0029, 0.0051) (=(1/0.9720 - 1, 1/0.9512 - 1)), which implies that farmers discount the utility of future consumption at a rate somewhere between 2.9 and 5.1% per year.

The point estimate of the parameter associated with preferences for intertemporal substitution is (rho) = 0.863. The most interesting hypothesis test concerning this parameter is whether (rho) (less than) 0, (rho) = 0, or (rho) (greater than) 0, implying EIS (less than) 1, EIS = 1, and EIS (greater than) 1, respectively. This is true because Epstein showed that the substitution (income) effect of a rise in asset returns dominates when EIS (greater than) ((less than))1, causing current consumption to fall (rise) and savings to rise (fall), which in turn causes asset prices to rise (fall) until equilibrium is restored. Furthermore, Campbell and Weil (1993) proved that GEU model (1) yields a constant consumption-wealth ratio equal to (1 - (beta)) (i.e., the marginal propensity to consume equals (1 - (beta))) when EIS = 1, independently of the **value** of CRR.

Imposing the restriction that (rho) (less than) 1 yields a 95% confidence **interval** for (rho) of (0.699, 1), so that the associated 95% confidence **interval** for EIS is (3.32, (infinity)). Therefore, the null hypothesis of (H.sub.0): EIS (less than or equal to) 1 is strongly rejected. It must be noted, however, that although the lower bound of the 95% confidence **interval** for EIS may be considered acceptable (e.g., Campbell), most of the values in such **interval** seem too large to be credible (e.g., Hall 1988).

Empirical estimates of (gamma) (equivalent) (alpha)/(rho) = (1 - CRR)/(1 - 1/EIS) are relevant for several reasons. First, (gamma) = 1 (i.e., EIS = 1/CRR) implies that the standard forward-looking expected utility model is valid. Second, (gamma) = 0 yields the special case of logarithmic risk preferences (i.e., CRR = 1). Third, Epstein and Zin (1991) demonstrated that the static capital asset pricing model (CAPM) of Sharpe and Lintner results if CRR = 1 in GEU equation (1), whereas the consumption CAPM (Merton, Breeden) is attained if CRR = 1/EIS (neq) 1 instead. Fourth, Campbell showed that if (gamma) (greater than) ((less than))0, agents tend to postpone consumption to the future (accelerate present consumption) in response to an increase in the degree of uncertainty about consumption growth relative to assets' rates of return.

The point estimate of (gamma) equals (gamma) = -0.159, and the associated 95% confidence **interval** is (-0.239, -0.079). This confidence **interval** for (gamma) implies that the standard

multiperiod expected utility model is rejected in favor of the GEU paradigm, and that farmers' risk preferences are unlikely to have a logarithmic representation. Since (gamma) is significantly smaller than zero, it is also true that neither the static CAPM nor the consumption CAPM (which are attained when (gamma) = 0 and (gamma) = 1, respectively) are likely to be adequate models of the behavior of agricultural asset prices. Further, (gamma) (less than) 0 implies that farmers respond to increases in the degree of uncertainty about consumption growth relative to assets' rates of return by accelerating present consumption (and reducing savings).

A confidence **interval** for CRR cannot be calculated from the data reported in table 2, because CRR = l-(gamma)p. However, a point estimate CRR, along with its associated standard deviation, may be obtained by performing a second-order Taylor series approximation around the point estimates (gamma) and (rho) This yields CRR = 1.136, and a 95% confidence **interval** equal to (1.061, 1.211). These values confirm the previous finding that farm risk preferences are not logarithmic (in which case CRR = 1), albeit CRR is so close to unity that it is an open question whether the difference is economically relevant. Also, the estimated CRR is consistent with the values suggested by the literature as "reasonable" (see Kocherlakota for a discussion). Interpreting the relative values of CRR and EIS in the light of the theoretical results by Weil (1990) and Farmer, it may be concluded that farmers prefer an early resolution of consumption uncertainty because it is clearly the case that CRR (greater than) 1/EIS.

The estimates just discussed were obtained by fitting the GEU model to the entire 1936-94 sample. But such a period is sufficiently long to question whether farmers' preferences remained unchanged throughout. For this reason, the bottom two rows of table 2 report the results obtained by partitioning the sample into two subsamples of equal length; namely, 1936-64 and 1966-94. As expected, almost all of the parameters are estimated with less precision when fewer observations are used. Most notably, however, all point estimates except for (gamma) in the subsample 1936-64 are quite similar to those obtained using the entire sample. The corresponding Wald test for parameter instability (Hamilton, p. 425) yields a critical **value** of (((chi).sup.2).sub.3) = 14.14, indicating a strong rejection of the null hypothesis that all of the parameter values remained unchanged across subsamples.

As suggested by the results shown in the bottom rows of table 2, this rejection is due to instability in (gamma) This implies that CRR = 1 - (gamma)(rho) (but not EIS = 1/(1- (rho))) changed significantly over the period analyzed. In particular, the point estimate of CRR equals 2.51 for 1936-64 and 1.13 for 1966-94, and the 95% confidence **intervals** for CRR are (1.34, 3.67) and (1.08, 1.18), respectively. In other words, the data suggest that farmers' relative aversion to risk decreased significantly over the period under study. This finding is consistent with the hypothesis that those farmers who exited the sector tended to be more risk averse than average, and seems important enough to deserve further research efforts.

It is also of interest to compare empirically the GEU model with the myopic model. The estimated myopic model is reported in table 3. As with the GEU model, for estimation purposes (alpha) was not restricted to lie within the allowed theoretical range (alpha) (less than) 1. In contrast to the GEU results, (alpha) was outside of the theoretically admissible range when using the entire sample, as well as the 1966-94 sub-sample. Interestingly, the myopic 95% confidence **interval** for CRR = 1 - (alpha) includes the GEU point estimate of CRR. However, the myopic CRR is estimated with much less precision than its GEU counterpart. Overall, the present results suggest that the GEU model fits the data better than the myopic model typically used in production **analysis** under risk.
Finally, caveats about the myopic (alpha) notwithstanding, the increase from (alpha) = -20 for 1936-64 to (alpha) = 8.2 for 1966-94 is reassuring in that it is consistent with the aforementioned GEU results that farmers' relative aversion to risk seems t o have diminished over time.

Concluding Remarks

The present study focuses on the simultaneous estimation of farmers' time preferences and risk attitudes. The relevance of quantifying time preferences is provided, along with a comparison of the typical model used in production risk **analysis** ivs-a-vis the generalized expected utility (GEU) paradigm advocated here.

The GEU model is applied to estimate time preferences and risk attitudes of U.S. farm operators using available aggregate data on consumption and asset returns. Estimation is performed using the generalized method of moments. The estimated preference parameters are found to exhibit much greater precision than the ones obtained in related studies using more aggregate data sets. Empirical results indicate a strong rejection of the standard forward-looking expected (power) utility model in favor of the GEU framework. It is estimated that farmers discount the utility of future consumption at an annual rate of around 3 to 5%, and that their preferences are characterized by a relatively high substitutability of consumption across time. Using the entire data set, farmers' coefficient of relative risk aversion is found to be greater but relatively close to unity. However, unlike the time preference parameters, the coefficient of relative risk aversion changed significantly throughout the period under study. In parti cular, farmers have become less averse to risk over time.

Based on results from the theoretical literature, the estimated magnitudes of the elasticity of intertemporal substitution and the coefficient of relative risk aversion imply that:

* Farmers tend to reduce savings and accelerate present consumption in response to an increase in the degree of uncertainty about consumption growth relative to assets' rates of return.
* Farmers prefer an early resolution of consumption uncertainty
* Farmers tend to increase savings and reduce current consumption in response to a rise in future agricultural asset returns.
* Neither the static CAPM nor the consumption CAPM, the two dominant asset pricing theories, provide adequate models of the behavior of agricultural asset prices.

It is shown that it is impossible to perform a simple nested test of the GEU model versus the myopic approach typically used in production **analysis** under risk, because neither one nests the other.
However, it is apparent that for this particular data set the myopic model's empirical performance is inferior to that of the GEU model. The myopic approach yields very imprecise estimates of the coefficient of relative risk aversion. Interestingly, however, the myopic estimates are consistent with the GEU results that farmers' relative aversion to risk diminished over time.

Undoubtedly, the agricultural economics literature has been overwhelmingly concerned with farmers' attitudes toward risk as opposed to farmers' intertemporal preferences. The present study shows that neglecting farmers' intertemporal preferences prevents one from providing adequate answers to questions about fundamental policy issues in agriculture. The latter include, among others, problems involving consumption, investment, asset prices, and interest rates.

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(1.) For example, policies regarding (a) interest rates; (b) the taxation of interest, capital, and capital gains; and (c) the subsidization of investment.

(2.) One recent exception is Barry, Robison, and Nartea, who focused on farmers' intertemporal preferences, but under certainty.

(3.) The cases of (rho) = 0 and (alpha) = 0 yield logarithmic intertemporal preferences and logarithmic risk preferences, respectively. They are omitted because of space considerations, and because they yield identical estimation equations (see equations (3) and (4)).

(4.) All prices are expressed in real terms with the consumption good as the numeraire. This is the reason that, for empirical purposes, all nominal amounts are deflated using the index of prices paid by farmers for family living.

(5.) A similar highlight for CRR is omitted because most agricultural economists are quite familiar with this concept, and numerous excellent analyses can be found elsewhere (e.g., Pratt, Hirshleifer and Riley, Altug and Labadie).

(6.) It is trivial to show that the existence of two or more assets yielding different risk-free rates of return implies arbitrage opportunities (and therefore no market equilibrium).

(7.) In production **analysis**, "investments" ((a.sub.i,t)) should be interpreted as expenditures in production inputs.

(8.) Regarding the use of aggregate instead of individual farm data to test the theoretical model's restrictions, it must he noted that 'the (latter) apply to average behavior if wealth, but not preferences, varies across (farmers)" (Epstein and Zin 1991, p. 273). That is, the theoretical model applies not only to an individual agent, but it also applies (under certain conditions) to a "representative agent" whose parameters are well-defined composites of the risk and time preferences of heterogeneous individual agents (e.g., Altug and Labadie p. 22, Milne p. 64, Huang and Litzenberger ch. 5, and Ingersoll ch. 10). Hence, the appropriate interpretation of the estimated parameters is that they correspond to a "representative agent" of the farm sector.

(9.) This ensures that the restriction that instruments be known a priori to be uncorrelated with the errors is satisfied.

(10.) This is, each variable is regressed on the lagged values of the three variables.

(11.) The terms (RE.sub.t), (GCEB.sub.t), and (LF.sub.t) ((RE.sub.t-1) and (LF.sub.t-1)) are multiplied by (PREO.sub.t) ((PREO.sub.t-1)) in the original expression for (NRRE.sub.t). Equation (A8) is obtained by simplifying such an expression.

(12.) Implicit in equation (A12) is the assumption that farm **financial** assets appreciate at the inflation rate. This seems reasonable, given that most of such assets are in the form of cash and savings deposits. At any rate, changes in NROE due to alternative definitions of farm **financial** asset appreciation are negligible because farm **financial** assets are a very small proportion of total farm assets.

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Instrumental Variables Used for Estimation

Instrumental Variables: (GFIPF.sub.1)/(GFIPF1.sub.t-1),
(TPEPF.sub.t)/(TPEPF.sub.t-1),
(RENT.sub.t)/(RENT.sub.t-1),
(IRFCS.sub.t)/(IRFCS.sub.t-1),
(IRPREM.sub.t)/(IRPREM.sub.t-1),
(INF.sub.t).

Definitions: (GFIPF.sub.t) (equivalent) (GFI.sub.t)/(NF.sub.t),
(TPEPF.sub.t) (equivalent) (TPE.sub.t)/(NF.sub.t),
(IRPREM.sub.t) (equivalent) (IRFCS.sub.t) - (TBILL.sub.t),
(INF.sub.t) (equivalent) (IPFL.sub.t)/(IPFL.sub.t-1),

where GFIPF denotes gross farm income per farm, TPEPF equals total production expenses per farm, RENT is the sample average of cash rents per acre of farm real estate for nineteen states, IRFCS represents the interest rate on new agricultural real estate loans charged by the Farm Credit System, IRPREM denotes interest rate premium, INF is the inflation rate, GFI equals gross farm income, NF stands for number of farms, TPE denotes total production expenses, TBILL is the interest rate on three-month Treasury Bills, and IPFL is the index of prices paid by farmers for family living.

Sources: Economic Indicators of the Farm Sector: National **Financial** Summary (GFI, TPE, NF), Johnson (GFI, TPE), USDA(1973) (NE), Jones (RENT), U.S. Department of Commerce (TBILL), Federal Reserve Bulletin (TBILL), and Agricultural Statistics (IPFL, IRFCS).

Appendix: Data

The RWFO series is obtained as follows:

(A1) (RWFO.sub.t) (equivalent) (NWFO.sub.t)/(IPFL.sub.t),

(A2) (NWFO.sub.t)
(equivalent) (((GCI.sub.t) + (VHC.sub.t) + (OFI.sub.t))/(NF.sub.t)
+ (delta)(DO.sub.t)) - {(((TPE.sub.t) - (CC.sub.t))
+ (GCEM.sub.t) + (PREO.sub.t) x (GCEB.sub.t))/
(NF.sub.t) + (ARE.sub.t) + (AFA.sub.t)},

(A3) (delta)(DO.sub.t) (equivalent) ((NRED.sub.t) + (PREO.sub.t) x (RED.sub.t))/
(NF.sub.t) - ((NRED.sub.t-1) + (PREO.sub.t-1)
x (RED.sub.t-1))/(NF.sub.t-1),

(A4) (PREO.sub.t) (equivalent) (LOFO.sub.t)/((LOFO.sub.t) + (LRFO.sub.t)),

(A5) (ARE.sub.t) (equivalent) ((RE.sub.t)/(LF.sub.t) + (RE.sub.t-1)/(LF.sub.t-1)/2) x ((PREO.sub.t) x (LF.sub.t)/(NF.sub.t) - (PREO.sub.t-1) x (LF.sub.t-1)/(NF.sub.t-1)),

(A6) (AFA.sub.t) (equivalent) ((IPFL.sub.t) + (IPFL.sub.t-1)/2) x ((FA.sub.t)/(IPFL.sub.t)/(NF.sub.t) - (FA.sub.t-1)/(IPFL.sub.t-1)/(NF.sub.t-1)),

where NWPO denotes nominal withdrawals per farm operator, IPFL is the index of prices paid by farmers for family living, GCI equals gross

cash income, VHC is the **value** of home consumption, OFI represents off-farm income, NF is the number of farms, (delta)DO equals the change in farm debt per operator, TPE are total production expenses, CC denotes capital consumption (including operator's dwellings), GCEM(GCEB) are farm gross capital expenditures in motor vehicles and other machinery and equipment (buildings and land improvements), PREO is the proportion of farm real estate owned by farm operators, ARE(AFA) is the **value** of the acquisitions of farm real estate (**financial** assets) per operator, RED(NRED) equals real estate (non-real estate) debt including dwellings, LOFO is the land owned by farm operators, LRFO equals the land rented from others, RE denotes farm real estate **value** including dwellings, LF represents land in farms, and FA is the total **value** of farm **financial** assets.

The RRRE series is defined as

(A7) (RRRE.sub.t) (equivalent) (NRRE.sub.t)/((IPFL.sub.t)/(IPFL.sub.t-1)) - 1,

(A8) (NRRE.sub.t) (equivalent) (((RE.sub.t) - (GCEB.sub.t) + ((NFI.sub.t) - (ROLM.sub.t)) x (RETA.sub.t-1)/(PREO.sub.t))/(LF.sub.t))/((RE.sub.t-1)/(LF.sub.t-1)),

(A9) (RETA.sub.t) (equivalent) (PREO.sub.t) x (RE.sub.t)/(NRE.sub.t) + (PREO.sub.t) x (RE.sub.t),

where NRRE denotes nominal gross rate of return to operator-owned farm real estate, (11) NFI equals net farm income, ROLM is the return imputed to operator's labor and management, RETA represents the ratio of operator's total farm real estate **value** to operator's total farm assets, and NRE are farm non-real estate assets.

Finally, the RROE series is calculated as

(A10) (RROE.sub.t) (equivalent) (NROE.sub.t)/((IPFL.sub.t)/(IPFL.sub.t-1)) - 1,

(A11) (NROE.sub.t) (equivalent) 1 + (((NFI.sub.t) - (ROLM.sub.t)) + (FAA.sub.t) + (ATA.sub.t) + (FMA.sub.t) + (REA.sub.t))/((NRE.sub.t-1) - (NRED.sub.t-1) + (PREO.sub.t-1) x ((RE.sub.t-1) - (RED.sub.t-1))),

(A12) (FAA.sub.t) (equivalent) ((IPFL.sub.t)/(IPFL.sub.t-1) - 1)(FA.sub.t-1),

(A13) (ATA.sub.t) (equivalent) ((API.sub.t)/(API.sub.t-1) -1)(AT.sub.t-1),

(A14) (FMA.sub.t) (equivalent) ((MPI.sub.t)/(MPI.sub.t-1) -1) (FM.sub.t-1),

(A15) (REA.sub.t) (equivalent) (((RE.sub.t) - (GCEB.sub.t))/(LF.sub.t)-(RE.sub.t-1)/(LF.sub.t-1)) x ((PREO.sub.t-1) x (LF.sub.t-1)),

where NROE equals nominal gross rate of return to operator's farm equity, FAA (ATA , FMA, REA) denotes farm **financial** assets (farm autos and trucks, farm machinery, operator's farm real estate) appreciation, (12) API(MPI) is the index of prices paid by farmers for autos and trucks (farm machinery), and AT(FM) represents the **value** of autos and trucks (farm machinery).

The sources for the (original series) used in (A1) through (A15) are as follows: Economic Indicators of the Farm Sector: National **Financial** Summary (GCI, VHC, TPE, CC, GCEM, GCEB, NF, LF, RE, FA, NRED, RED, OFI, NFI, ROLM, NRE, AT, and PM), Johnson (GCI, VHC, TPE, CC, GCEM, GCEB, and NFI), Census of Agriculture (LOPO and LRPO), Melichar (FA, NRED, RED, ROLM, and NRE), USDA (1973) (NP and LF), U.S. Department of Commerce (RE), and Agricultural Statistics (NRED, RED, OFI, IPFL, API, and MPI).

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File Segment: TI File 148

30/9/16 (Item 16 from file: 16)
07962518 Supplier Number: 66450504

Screening for Type 2 Diabetes.
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Diabetes Care , v 23 , n 10 , p 1563
Oct , 2000
ISSN: 0149-5992
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Refereed ; Professional
Word Count: 15404

Text:

In 1997, nearly 16 million people in the U.S. had diabetes (1,2). Of this population, (sim)10.3 million were diagnosed and 5.4 million were undiagnosed (1,2). In the future, these numbers are expected to increase substantially (3). Type 2 diabetes accounts for 90-95% of all cases of diabetes in the U.S. (4,5), making it and its attendant clinical and economic consequences a major public health problem (6,7).

What role should screening for undiagnosed type 2 diabetes in asymptomatic adults play in combating the epidemic of diabetes (8)? Despite a lack of firm evidence for the benefit of early detection of type 2 diabetes through screening (9-11), several health organizations have recommended it for several reasons (12-15). First, one-third to one-half of type 2 diabetes is undiagnosed and, hence, untreated (2,3,16-21). Second, diabetic complications are frequently present at clinical diagnosis (22-28). Finally, earlier diagnosis and treatment is believed to prevent or delay such complications and improve health outcomes (29).

Although the benefits of early detection and treatment of type 2 diabetes seem intuitive, the decision to screen should be based on the best available evidence. In this review; we examine the evidence for and against screening for type 2 diabetes to help focus the debate on whether screening asymptomatic adults for diabetes should be incorporated into public policies.

PRINCIPLES OF TYPE 2 DIABETES SCREENING -- There is a major distinction between diagnostic testing and screening. When an individual exhibits symptoms or signs of the disease, diagnostic tests are performed and such tests do not represent screening. The purpose of screening is to differentiate an asymptomatic individual at high risk from an individual at low risk for diabetes. Screening may use a variety of methods (e.g., risk assessment questionnaires, portable capillary blood assessments, and laboratory-based assessments) and various thresholds or cutoff points. In general, though, a screening test is not part of the diagnostic test. Ideally, screening tests are rapid, simple, and safe (11,30-32). A positive screening test only means the subject is more likely to have the disease than a subject with a negative screening test. Separate diagnostic tests using standard criteria (15) are required after positive screening tests to establish a definitive diagnosis. Clinicians should continue to be vigilant in rec ognizing clinical presentations that may be related to diabetes and should determine plasma glucose levels in the evaluation of patients with a history or symptoms suggestive of diabetes; this is not screening, but rather appropriate clinical care and diagnosis.

Generally, screening is appropriate in asymptomatic populations when

seven conditions are met (11,30-41): 1) the disease represents an important health problem that imposes a significant burden on the population; 2) the natural history of the disease is understood; 3) there is a recognizable preclinical (asymptomatic) stage during which the disease can be diagnosed; 4) treatment after early detection yields benefits superior to those obtained when treatment is delayed; 5) tests are available that can detect the preclinical stage of disease, and the tests are acceptable and reliable; 6) the costs of case finding and treatment are reasonable and are balanced in relation to health expenditures as a whole, and facilities and resources are available to treat newly detected cases; and 7) screening will be a systematic ongoing process and not merely an isolated one-time effort. We will critically review the available evidence with respect to each of these issues as they pertain to screening asymptomatic adults for type 2 diabetes.

Question 1: Does diabetes represent an important health problem that imposes a significant burden on the population?

In brief, the answer to Question 1 is yes. In 1995, the estimated prevalence of diabetes among adults was 7.4%, and it is expected to rise to 8.9% by 2025 (3). Diabetes is a major cause of visual impairment and blindness (42-45), end-stage renal disease (ESRD) (46,47), and nontraumatic lower-extremity amputations (48-51). It also contributes substantially to cardiovascular disease, stroke, peripheral vascular disease, disability, premature mortality and congenital malformations and perinatal mortality among offspring of diabetic mothers (48,52-55). Despite potential under-reporting, diabetes is currently listed as the seventh leading cause of death among the general population, and it ranks even higher among some minority populations (56).

Diabetes consumes an extraordinary amount of medical resources in the U.S. One recent study found that although the prevalence of diabetes was 5%, care for patients with diabetes accounted for (sim)15% of health care expenditures (6,7). Diabetic individuals consumed health care resources at rates two to three times that of nondiabetic individuals (6). Indirect costs from losses in productivity though poorly characterized, are also substantial (57).

Question 2: Is the natural history of type 2 diabetes well understood?

The answer to Question 2 is yes. Diabetes progresses through several identifiable stages. Figure 1 outlines the clinical stages most relevant to diabetes screening. Biological onset is followed by a period during which the disease remains undiagnosed (2,4,17-20,58). Initially, postprandial hyperglycemia may be the primary defect. Subsequently, fasting hyperglycemia may develop. Early on, the disease may be difficult to detect with screening; then, as hyperglycemia increases, screening tests can more readily detect it. As a part of "routine" or incidental laboratory testing or in response to symptoms, a test is performed and the diagnosis is established. If not already present at diagnosis, diabetic complications develop in relation to the duration and degree of hyperglycemia and may result in major disability and, ultimately, death. Risk factors for diabetic complications are now fairly well characterized. Major risk factors for microvascular complications include duration of diabetes, poor glycemic control, and hypertension; major risk factors for macrovascular disease include hypertension, dyslipidemia, smoking, and possibly poor glycemic control.

Question 3: Does diabetes have a recognizable preclinical (asymptomatic) stage during which the disease can be diagnosed?

Again, the answer is yes. By using the same diagnostic criteria used for symptomatic individuals (Table 1) (15), diabetes can be diagnosed in asymptomatic individuals. Population-based studies designed to estimate the prevalence of diabetes have generally found that one-third to one-half of all diabetes is undiagnosed (2,4,17-20,58). The duration of the preclinical stage has been estimated by extrapolation from the prevalence of complications at clinical diagnosis (59). Studies of people with newly

diagnosed type 2 diabetes have found that 2-39% have retinopathy (22-26), 8-18% have nephropathy (27,60,61), 5-13% have neuropathy (4,22,62), and 8% have cardiovascular disease (60). Furthermore, the prevalence of cardiovascular and peripheral vascular disease and the incidence of premature death are similar to those of people with established diabetes (28,63,64). Using the assumptions that the prevalence of retinopathy is linear with duration of diabetes and that the prevalence is zero in the nondiabetic populatio n, one study estimated the duration of preclincial diabetes to be 9-12 years before clinical diagnosis (26). Another study used a nonlinear regression model and estimated the preclinical duration to be between 7 and 8 years (65). Thus, depending on the investigators' assumptions and the populations studied, the preclinical phase may vary. In addition, while interpreting these studies, it is important to recognize that some, though probably not all, of the complications at diagnosis may arise from lesser degrees of hyperglycemia than those currently considered diagnostic for diabetes (66). If diabetic complications develop at glucose levels below the current diagnostic thresholds, the average duration of recognizable preclinical diabetes would tend to be reduced.

Question 4: Does treatment after early detection of type 2 diabetes yield benefits superior to those obtained when treatment is delayed?

The answer to question 4 is a qualified yes. Although the benefits of improved glycemic control in type 2 diabetes are now established, the benefits and risks of screening and early treatment are less clear. Very little is known about how well asymptomatic individuals who have been diagnosed after screening will comply with advice about diet and exercise, or a medication regimen. If patients largely ignore advice about diet and exercise and if pharmacological therapy is associated with substantial side effects, the benefits of early detection through screening may be small.

Benefits and risks of screening for type 2 diabetes. Randomized control trials (RCTs) would be the best means to evaluate the benefits and risks of diabetes screening and early treatment. RCTs are superior to case-control designs or observational studies because they measure the effect of the screening procedure alone and not other health behaviors that make an individual submit to screening (67). In an RCT, a control population receives r outine clinical care; that is, the subjects are tested and treated for diabetes after clinical diagnosis, usually at the onset of symptomatic fasting hyperglycemia. This population is compared with an intervention population--a population periodically screened for diabetes and diagnosed before symptomatic hyperglycemia develops--and is treated from the time of diagnosis. Over the course of the clinical trial (and preferably over the lifetime of the patient), the benefits and risks of screening are assessed by comparing short- and lorig-term health outcomes.

Unfortunately, rigorous studies that apply currently available treatments to a screened group but not a control group have not happened and are unlikely to happen because of feasibility ethical concerns, and costs (68,69). **Random** assignment to the control group might be seen as unethical because several health organizations have already recommended screening. In addition, because the incidence of diabetes is low and the benefits of screening may be small and accrue over many years, large numbers of participants and long-term follow-up would be required and would necessitate substantial resources. The unfortunate result of the lack of RCTs on screening for type 2 diabetes is that we have poor empirical data as to the quantifiable benefits and risks of screening.

The available studies on screening for type 2 diabetes can suffer from four types of bias that may lead to spurious conclusions: selection, lead time, length time, and over-diagnosis bias (Table 2) (31,34). Selection bias occurs if screen-detected individuals are more likely to have good health outcomes regardless of whether they are screened. For example, people who volunteer to participate in screening programs maybe more likely to follow health recommendations and to engage in preventive health practices than people who do not volunteer and are diagnosed through standard procedures. Thus, volunteers for screening may prevent or delay

diabetic complications for reasons other than early detection. Lead time is the period between detection of disease by screening and diagnosis through standard procedures. A direct comparison between individuals detected through screening and those whose diabetes was diagnosed through standard procedures would demonstrate a longer **interval** before the development of diabetic c omplications in subjects detected through screening, even if early detection and treatment did not alter the natural history of the disease. This is an example of lead-time bias. Length-time bias occurs if screen-detected subjects have a slower natural progression of disease, which results in lower morbidity and mortality The probability that a person is detected through screening depends on the duration of the preclinical disease state (31). Thus, a person who has a short preclinical state has a smaller chance of being detected before becoming symptomatic. On the other hand, a person with a long preclinical stage is more likely to be detected in a screening program. Thus, screening would tend to detect subjects with milder disease and slower progression, and follow-up would demonstrate better clinical outcomes in these individuals compared with clinically diagnosed individuals regardless of any effect of treatment. Over-diagnosis bias can occur when rigorous screening efforts result in diagnoses being made a mong subjects who do not have the disease (34). In addition, overdiagnosis bias can occur during screening initiatives when subjects with positive screening tests are declared to have diabetes in the absence of complete diagnostic testing. Because such individuals may not have the disease, they have a more favorable course and prognosis than people diagnosed through standard procedures, which results in an apparent, though not real, health benefit.

Because of the lack of RCTs, rigorous data about the risks of screening are also lacking. Nevertheless, several assumptions about risks may be made. Screening results falsely suggesting disease may expose patients to additional testing, follow-up, and treatment that may be inappropriate, bothersome, unpleasant, or hazardous. Currently such negative effects are poorly understood, but may be considered in the broad categories of physical, psychological, and social harm (33,36). Exposure to diagnostic tests may result in physical harm (e.g., nausea and vomiting after ingestion of oral glucose load during an oral glucose tolerance test (OGTT)), and screening for other comorbidities may be associated with complications (e.g., hematoma after coronary angiography for ischemic heart disease). In addition, hypoglycemia might result from earlier and more aggressive treatment, as described later. The risks associated with drug or insulin therapy in screen-detected populations are not known, although it is clear that hy poglycemia occurs more frequently with intensive treatment. With respect to psychological and social harm, screening may increase worry and reduce health-related quality of life (QOL). In addition, both the sequellae of inappropriate labeling with diabetes and misdiagnosis after screening must be considered (70). After being diagnosed with diabetes, patients may have difficulty obtaining health insurance or employment. In addition, people without diabetes who have positive screening tests (false positives) are subject to the risks and costs of unnecessary evaluations. On the other hand, people with diabetes who have negative screening tests (false negatives) will not receive appropriate diagnostic testing and will be falsely reassured that they are disease-free.

Benefits and risks of improved glycemic control. Even though scant empirical data exist about the risks and benefits of screening per se, people with newly diagnosed diabetes typically have glucose levels that warrant treatment. For example, in the U.K. Prospective Diabetes Study (UKPDS), the average (HbA.sub.1c) **value** among people with newly diagnosed type 2 diabetes at recruitment was 9.0% (71). Therefore, it is relevant to this review to examine the benefits (i.e., microvascular, macrovascular, and mortality outcomes) and the risks (i.e., hypoglycemia, weight gain, and QOL) associated with improved glycemic control in type 2 diabetes. Here, the data from relevant RCTs and disease models are much

stronger and suggest a favorable benefit-to-risk ratio among subjects who are diagnosed through standard clinical practice.

Two RCTs have demonstrated the benefits of improved glycemic control on microvascular outcomes. The Kumamoto Study investigated 110 nonobese Japanese subjects with insulin-treated type 2 diabetes over 6 years (72) and found that intensive glycemic control yielded a 30-60% reduction in development and progression of microvascular complications. The Diabetes Control and Complications Trial (DCCT) found similar reductions among people with type 1 diabetes (73). The UKPDS compared a conventional dietary treatment policy with two intensive treatment policies based on sulfonylurea and insulin (3,867 people aged 25-65 years, with newly diagnosed type 2 diabetes, fasting plasma glucose levels of 6.1-15.0 mmol/l after 3 months of dietary therapy and no symptoms of hyperglycemia) (71). The absolute difference in the median (HbA.sub.1c) between the intensive (both sulfonylurea and insulin) and conventional treatment groups was 0.9%, which was less than the (sim)2% difference observed between groups in the Kumamoto Stud y and the DCCT. Compared with conventional treatment, intensive therapy significantly reduced any diabetes-related end point (40.9 vs. 46.0 events/1,000 person-years) (71). Secondary **analysis** demonstrated that intensive therapy resulted in a significant reduction in microvascular end points (8.6 vs. 11.4/1,000 person-years) compared with conventional treatment (71). In general, the relative risks of retinopathy, nephropathy, and neuropathy were all significantly reduced.

These two RCTs have also examined the relationship between glycemic control and macrovascular disease and mortality In the Kumamoto Study the number of major cerebrovascular, cardiovascular, and peripheral vascular events in the intensive treatment group was half of that in the conventional treatment group, but the event rate was low and the differences were not statistically significant (72). In the UKPDS, intensive versus conventional treatment showed nonsignificant reductions in the risk of myocardial infarction and in diabetes-related and all-cause mortality (71).

With improved glycemic control, the risk of hypoglycemia may increase. In the Kumamoto Study, there was no significant difference in rates of hypoglycemia between groups (72). In the UKPDS, the rates of major hypoglycemic episodes per year were 0.7% with conventional treatment, 1.0% with chlorpropamide, 1.4% with glibenclamide, and 1.8% with insulin (71). Patients in the intensive treatment group had significantly more hypoglycemic episodes than those in the conventional treatment group (P (less than) 0.0001) (71). Major hypoglycemic episodes occurred in 0.6% of overweight patients in the metformin-treated group (74).

Improved glycemic control may also be associated with weight gain. In the Kumamoto Study, there was a slight increase in BMI in both groups from baseline to 6 years; this increase, though, was not statistically significant (intensive treatment group 20.5-21.2 vs. 20.3-21.9 kg/(m.sup.2), respectively, in the intensive vs. conventional treatment groups) (72). However, in the UKPDS, weight gain was significantly greater in the intensive treatment group than in the conventional treatment group with a mean increase of 2.9 kg (P (less than) 0.001) (71). Compared with the conventional treatment group, patients assigned to insulin treatment had a greater gain in weight (4.0 kg) than those assigned to chlorpropamide (2.6 kg) or glibenclamide (1.7 kg) (71). Overweight patients **randomly** assigned to intensive treatment with metformin had a change in body weight similar to those subjects receiving conventional treatment and a lower increase in mean body weight compared with those subjects receiving intensive treatment wi th sulfonylureas or insulin (74).

Improved glycemic control may require more intensive self-care and substantial lifestyle changes. Thus, QOL may be affected by these treatment regimens. The UKPDS assessed disease-specific and generic measures of QOL in two large cross-sectional samples at 8 years (n = 2,431) and 11 years (n = 3,104) after randomization and disease-specific QOL in a small cohort of

subjects (n = 374) at 6 months and annually thereafter for 6 years (75). The serial cross-sectional studies showed that the type of therapy was neutral in effect; there was neither improvement nor decline in QOL scores for mood, cognitive mistakes, symptoms, work satisfaction, or general health. Besides the observation of slightly more symptoms in patients allocated to conventional versus intensive therapy, the longitudinal study also showed no differences in QOL scores for the specific domains assessed.

QOL was affected by the occurrence of hypoglycemia in the UKPDS (75). Patients treated with insulin who had two or more hypoglycemic episodes during the previous year reported more tension, more overall mood disturbance, and less work satisfaction, as measured by the disease-specific questionnaire, than those with no hypoglycemic attacks. Although it was unclear whether frequent hypoglycemic episodes affected QOL or whether patients with certain personality traits or symptoms simply reported increased numbers of hypoglycemic attacks, the investigators concluded that therapeutic policies that reduce the risk of complications do not affect QOL.

Recently, two diabetes disease models have been used to estimate the benefits of glycemic control in type 2 diabetes. The first, a Markov model, examined the potential benefits of control for newly diagnosed complication-free members of a health maintenance organization (76). The model was constructed using the disease states (retinopathy nephropathy and neuropathy) and rates for early development of microvascular disease from the DCCT and values from the literature for the end-stage outcomes. Mortality estimates were based on U.S. vital statistics and were not adjusted for levels of glycemic control. The lifetime benefits were determined for a hypothetical intervention that reduced the (HbA.sub.1c) **value** from 9 to 7%. For a person diagnosed with diabetes at age 45 years, a reduction in the (HbA.sub.1c) **value** from 9 to 7% was estimated to decrease the lifetime risk of blindness by 2.3 percentage points (from 2.6 to 0.3%) and to lengthen life by 1.3 years. Benefits depended strongly on age and the baseline le vel of glycemic control.

Another study used a Monte Carlo simulation model to compare the lifetime benefits associated with early detection and treatment of type 2 diabetes based on one-time opportunistic (clinic-based) screening with diagnosis and treatment as it occurs in current clinical practice (77). Data for the model were obtained from clinical trials, epidemiological studies, and population surveys. A hypothetical cohort of 10,000 people from the U.S. population aged (greater than or equal to)25 years were followed from the onset of disease (assumed to be 10.5 years before clinical diagnosis and 5.5 years before screening diagnosis) until death. The lifetime incidence of ESRD, blindness, and lower-extremity amputation was reduced in the screened group by 26, 35, and 22%, respectively (Table 3). The mean duration free of these three major complications increased 0.08, 0.27, and 0.15 years, respectively The absolute lifetime risk reduction was greatest for blindness, for which the number needed to treat was just 31 (i.e., to p revent one case of blindness). The benefits of early detection and treatment were found to accrue more from postponement of complications and the resulting improvement in the QOL than from additional years of life gained.

This simulation model did not include any potential benefit from early initiation of glycemic control on the incidence of cardiovascular disease (77). It also did not include any possible benefits from the opportunity to influence macrovascular disease risk factor management. A model incorporating decreases in cardiovascular disease resulting from treatment to the more aggressive targets now recommended for patients with diabetes and hypertension (77a-c) and lipids (77d) might show a greater benefit. The model was moderately sensitive to assumptions about the performance of the screening test (sensitivity and specificity), the length of the preclinical diagnosis **interval** (a shorter **interval** was less cost-effective), the prevalence of undiagnosed diabetes (a higher prevalence was more cost-effective), and the intensity

of glycemic management.

In summary, no RCTs of screening have been conducted. Moreover, there are no empirical data to demonstrate the benefits of screening, and there are few data on risks. RCTs have demonstrated that improving (HbA.sub.1c) levels from those levels typically found among subjects after a routine clinical diagnosis of type 2 diabetes can decrease microvascular and neuropathic complications; the effects on macrovascular disease are not as clear. Early diagnosis after screening may provide an opportunity to prevent morbidity by both improved glycemic management and earlier recognition and treatment of complications. Indeed, timely laser therapy may prevent or delay visual loss (78-80), instituting ACE inhibitor therapy may prevent or delay ESRD (81,82), and initiating comprehensive foot care may prevent lower-extremity amputations (83,84). However, clinical trials of treatment of diabetes diagnosed through current clinical practice and screening models provide modest evidence to support the benefit of early detection and improved glycemic control in type 2 diabetes.

Question 5: Are there tests that can detect preclinical (asymptomatic) diabetes that are reliable and acceptable?

For the most part, the answer is yes. It is clear, however, that current screening recommendations are not entirely consistent with available evidence and that a number of important operational questions require further research.

Ideally, a screening test should be both sensitive (have a high probability of being positive when the subject truly has the disease) and specific (have a high probability of being negative when the subject does not have the disease). Generally however, a trade-off must be made between sensitivity and specificity Increasing sensitivity reduces specificity, and increasing specificity reduces sensitivity Screening tests should also be reliable and reproducible. Consistent results should be obtained when the test is performed more than once on the same person under the same conditions (85). Uniform procedures and methods, standardized techniques, properly functioning equipment, and quality control are necessary to ensure both reliability and reproducibility.

When considering a test or evaluating studies, one frequently examines the positive predictive **value** (PPV), which is defined as the probability of having diabetes when the screening test result is positive (11,85-87). The determinants of the PPV are the sensitivity and specificity of the screening test and the prevalence of disease in the population. When sensitivity and specificity are constant, the higher the prevalence of a disease and, thus, the higher the PPV of the screening test. Because an increase in PPV translates into more cases detected for each diagnostic test, it has important implications for resource use. Information about the type of population (e.g., volunteers and clinic-based patients) and the distribution of risk factors for diabetes (age, race or ethnicity family history, obesity and physical activity) can be used to target groups with a higher prevalence of diabetes and thereby enhance the PPV.

When evaluating studies of the performance of screening tests for type 2 diabetes, four issues must be considered: characteristics of the study population, the selection of cutoff points, referral policies for positive screening tests, and the nature of the definitive diagnostic test. The population's characteristics are important because the prevalence of diabetes in the population affects the PPV. The nature of the population may also affect the apparent performance of the screening test. For example, both sensitivity and specificity will be higher in populations that include subjects with severe hyperglycemia, which is also the case when subjects with diagnosed diabetes are included in the screened population. Distinguishing between subjects with decompensated diabetes who are experiencing frank fasting hyperglycemia and those without disease is easier than distinguishing between those with asymptomatic diabetes with mild hyperglycemia and those without diabetes. Thus, studies that include individuals wit h diagnosed diabetes should be interpreted cautiously.

The issue of cutoff points is important and must be explicit, particularly in relation to sensitivity and specificity (11,85). A high cutoff point for a positive test ultimately results in a low sensitivity and high specificity, and a low cutoff point results in a high sensitivity and low specificity. Ideally, receiver operating characteristic (ROC) curve analyses, which can evaluate performance over the entire range of cutoff points, should be used to compare tests (86,88-93). Unfortunately few studies have performed such analyses. Although not ideal, choosing a common specificity for each test allows for comparisons of the sensitivity, and choosing a common sensitivity allows for comparisons of specificity.

Referral policies used during evaluation studies are also extremely important. If only participants with positive screening tests are referred to receive verification by the gold standard test, then work-up bias occurs (i.e., diagnostic tests for type 2 diabetes are done only in those who screen positive, not in the entire study population). Work-up bias may substantially distort estimates of sensitivity and specificity if it is assumed that all people with negative screening tests do not have diabetes and that the screening test is 100% specific.

The final issue of the validity of the diagnostic test is important because some studies have not used definitive diagnostic testing with a recognized gold standard, thus making the assessment of sensitivity and specificity problematic.

Types of screening tests and their performance. We review two major methods used to screen for preclinical asymptomatic type 2 diabetes: questionnaires and biochemical tests.

Questionnaires. With questionnaires, self-reported demographic, behavioral, and medical information is used to assign a person to a higher or lower risk group for diabetes. Questionnaires are popular and are usually less expensive than biochemical tests, but, when used alone, they generally perform poorly.

In 1993, the ADA disseminated a questionnaire, titled "Take the Test. Know the Score" (95). This questionnaire assessed both symptoms and **historical** risk factors. Points were given for certain responses; a score of (less than or equal to)5 points was considered low risk for diabetes, and a score of (greater than)5 points was considered high risk. Subsequent testing among both U.S. (96) and U.K. (97) populations found that the test performed rather poorly. For example, in the U.K., when a score of (greater than)5 was used to predict subjects with **random** capillary glucose measurements of (greater than)6.5 mmol/l, the sensitivity was just 46% and the specificity was 59%. Regardless of the capillary glucose measurement, participants commonly reported symptoms of diabetes. Overall, approximately one-third of participants reported frequent urination, extreme fatigue, and blurred vision, and nearly one-fifth reported excessive thirst.

Two years later, another questionnaire was developed in the U.S. with data from the Second National Health and Nutritional Examination Survey (98). A test of the questionnaire in the population from which it was developed found a sensitivity of 79%, a specificity of 65%, and a PPV of 10% for detecting undiagnosed diabetes when using World Health Organization (WHO) criteria (99). By ROC curve **analysis**, the second questionnaire performed better than the ADA's 1993 questionnaire. Groups at high risk of diabetes were defined with five risk factors (older age, obesity, sedentary lifestyle, family history of diabetes, and delivering a baby weighing (greater than)4 kg). The questionnaire did not rely on past medical history to ensure its applicability to all populations, including the medically underserved, and to avoid depending on prior medical evaluations or care (100). The ADA has adapted this instrument for use in community-based diabetes screening programs (101). In doing so, some modifications were made to t he validated questionnaire. Subsequently, this adapted risk test was used in a community screening program in Onondaga County, New York, where it had an overall sensitivity of 80%, a reduced specificity of 35%, and a PPV of 11.9% (100,102).

Another questionnaire, developed in the Netherland's Hoorn Study population, incorporated symptoms (thirst, pain, and shortness of breath during walking), demographic and clinical characteristics (age, sex, obesity family history of diabetes, and hypertension), and exercise preferences (such as reluctance to use a bicycle for transportation) (103). When it was subsequently evaluated in a separate subgroup of the Hoorn Study population, this questionnaire was found to have a sensitivity of 56%, a specificity of 72%, and a performance slightly better than the ADA questionnaires for this population (as determined by ROC analyses).

In summary, diabetes screening questionnaires perform rather poorly as standalone tests. It is possible that they may be useful educational tools and may promote public awareness in low-risk populations, but their effectiveness has not been rigorously assessed (102,104).

Biochemical tests. Measurements of glucose and highly correlated metabolites (e.g., (HbA.sub.1c) and fructosamine levels) have been used extensively for diabetes screening (105-151). Urine glucose and venous and capillary blood glucose may be measured under various conditions--fasting, at **random**, postprandial, or after a glucose load--to represent different metabolic states. For some tests, such as those for glycosylated hemoglobin (total, (HbA.sub.1) fraction, and the (HbA.sub.1c) fraction), fructosamme, and anhydroglucitol, the immediate metabolic state is of relatively little importance. The characteristics of several biochemical screening tests and the PPV for a hypothetical population with a low prevalence (6%) and a high prevalence (12%) of undiagnosed diabetes are summarized in Table 4.

Measurement of glycosuria using a cutoff point greater than or equal to a trace **value** has a low sensitivity and a high specificity (Table 4). Performance is usually better with **random**, postprandial, or glucose-loaded measurements than with fasting measurements, perhaps in part because the renal threshold for glucose is reached more often in the nonfasting state. Thus, the usefulness of urine screening is limited.

Studies of fasting venous glucose screening tests often have used fasting measurements obtained as part of the diagnostic test. The 2-h glucose concentration from the OGTT from the same diagnostic test process has served as the gold standard test. In studies of populations in which subjects with previously diagnosed diabetes have been excluded and the populations have not been enriched with high-risk subjects (105,114,115,126,127), sensitivity has ranged from 40 to 65% at a specificity of (greater than)90%. Other studies have reported higher sensitivities (up to 95%) at specificities (greater than)90% (107,113,116,128-130), but some included subjects with diagnosed diabetes or populations with an increased proportion of individuals with abnormal glucose tolerance. Studies of fasting capillary glucose screening have reported performances similar to those for fasting venous glucose tests.

In studies that excluded subjects with overt diabetes, **random** and postprandial venous and capillary glucose tests performed better than fasting tests. This result occurs because subjects with undiagnosed diabetes are more likely to meet the 2-h OGTT diagnostic criterion versus the fasting criterion and have postprandial hyperglycemia versus fasting hyperglycemia (151). To obtain optimal performance from tests during **random** and postprandial states, higher cutoff points are needed to account for the postprandial state (and, in some cases, for age) (119,151).

Glycosylated hemoglobin measurements are becoming more widely available (152). With the use of various cutoff points, sensitivity of 15-67% has been reported at a specificity of (greater than)90% (Table 4). At a high specificity, higher sensitivities have been reported, but these were from studies in populations that included subjects with diagnosed diabetes or a high level of glucose intolerance (107,137).

In the past, problems with glycosylated hemoglobin measurements included a lack of standard reference materials and variations in the

reference methods of different assays. These problems have been addressed by the National Glycohemoglobin Standardization Program, which produced substantial improvements in both the precision and comparability of methods (152). Unfortunately, considerable variability remains, and some issues, such as comparability of samples containing hemoglobin variants, also remain. In addition, (HbA.sub.1c) levels, the most commonly used glycosylated hemoglobin measurement, may be unsuitable for diabetes screening: a study in a small cohort of subjects with normoglycemia (no diabetes) failed to find a relationship between fasting venous glucose and (HbA.sub.1c) values (153). Other research has found that only 2-30% of the nondiabetic variance in glycosylated hemoglobin can be explained by fasting or postload blood glucose; the remainder is presumably related to other factors independent of glycemia, such as the rate of glycation and differences in red blood cell survival (154,155).

Both anhydroglucitol, a polyol sugar alcohol found in reduced serum concentrations in diabetic subjects, and fructosamine, a measure of glycosylated total serum proteins, have been evaluated for diabetes screening (Table 4). Like glycosylated hemoglobin measurements, measurements of anhydroglucitol and fructosamine are independent of fasting status, but neither measurement has performed better than other available tests.

Combinations of biochemical tests have also been evaluated (Table 4). Using multiple tests in series (with second and subsequent screening tests performed only when the preceding test is positive) can enhance the PPV by increasing the prevalence of disease in the population receiving the second screening test. For example, a second screening test performed only in the population of individuals who had positive initial screening tests yields a "double-positive" population that will have a higher prevalence of disease than either test administered alone. Screening programs can initially use a less expensive and more sensitive test and then use the more complicated, more specific, and more expensive test (e.g., a questionnaire followed by capillary glucose measurement). Strategies that use multiple screening tests will not detect more undiagnosed cases (i.e., will not improve sensitivity) but may allow for more efficient use of resources.

In summary, review of the performance of various screening methods for detecting undiagnosed type 2 diabetes shows that questionnaires tend to perform poorly, whereas biochemical tests perform better. Venous and capillary glucose measurements perform better than urinary glucose or (HbA.sub.1c) measurements, and postprandial or post-glucose load glucose levels have advantages over fasting levels. Performance of all screening tests is dependent on the cutoff point selected. Currently there are no uniform cutoff points to define positive screening tests. A two-stage screening test strategy may assist with a more efficient use of resources, although such approaches have not been rigorously tested. Because test performance typically depends on the population being evaluated, interpretation within and across studies can be difficult. Another confounding factor is that the blood glucose tests used to screen for diabetes are the same tests used to diagnose diabetes. Therefore, providers often do not see a distinctio n between screening and diagnosing diabetes; thus, different cut points may be confusing.

Questions 6: Are the costs of case finding and treatment reasonable and balanced in relationship to health expenditures as a whole, and are facilities and resources available to treat newly detected cases?

The answer to the first part of this question is unclear; for the second part, the answer is a qualified yes. Limited information concerning the cost of screening is available, but the information that does exist indicates that screening for undiagnosed diabetes in asymptomatic adults may be problematic depending on the setting at which screening occurs.

Screening may be done at the community level or in the context of medical care. Three approaches to diabetes screening have been used: population-based, selective, and opportunistic. Population-based approaches

attempt to screen every person in the entire population. Epidemiological studies designed to assess diabetes prevalence often use this approach. However, because it is costly and potentially inefficient (due to the low prevalence of diabetes in the general population), this method is not widely favored (except in populations with a very high prevalence of diabetes). Selective screening targets subgroups of the population with a high prevalence of risk factors for diabetes (101,156,157). Opportunistic screening involves screening individuals during routine encounters with the health care system, such as primary care visits or periodic health appraisals (158-164). Both selective and opportunistic screenings require fewer resources to reach high-risk groups, to conduct screening tests, and to perform fol low-ups (160). Both may have poor coverage and a tendency to be misdirected--some people get too many tests too often, others get too few tests too infrequently (160).

Although community screening with the use of a selective method is both popular and common (70,165), fragmented health insurance coverage and variable access to health care may make it difficult to ensure both proper referrals for subjects who screen positive and appropriate repeat testing for subjects who screen negative (166). Although there is no evidence that the U.S. has too few health care providers to treat the additional cases of diabetes, access to providers is not universal because of the large number of people without health insurance. Furthermore, screening outside of clinical settings may mean that abnormal tests are never discussed with the primary care provider, that compliance with treatment recommendations is low and that a positive long-term impact on health is unlikely (167).

The resources demanded by diabetes screening include those associated with screening itself, diagnostic tests for people with positive screening tests, and additional years of care due to earlier diagnosis, which may result in higher lifetime costs compared with patients detected through current clinical practice. Use of equipment for self-monitoring of glucose levels and testing strips for screening are relatively inexpensive per test (less than $1.00), but the cost of plasma glucose ($5.00) and (HbA.sub.1c) measurements ($13.50) are substantially higher (according to 1998 Medicare costs). The costs of personnel time for consent, test performance, counseling, and especially follow-up are unknown but are clearly substantial.

Determining program costs and the burden on the health care system require a knowledge of the prevalence of undiagnosed diabetes, the methods of case finding, and the operations of the health care delivery system. In the U.S., up to 40 million people (nearly 18% of the population) have either no medical care coverage or inadequate medical coverage (168). Besides self-directed changes in health behaviors, for early detection to provide significant benefits, there must be ongoing receipt of diabetes care (9,40). If those individuals confirmed to have diabetes do not receive care, there can be little or no benefit in earlier diagnosis, and the cost of screening, no matter how small, cannot he justified (169).

The best case can probably be made for opportunist screening. The screening simulation model discussed earlier (77) is considered an opportunistic screening program for the general U.S. population aged (greater than or equal to)25 years. The identified cost per case was $1,200, which included a fasting plasma glucose screening test, an OGTT for those with a positive screening test, and physician time for test interpretation. Diabetes was diagnosed ~5.5 years earlier with the screening program, and the estimated average annual cost for treatment of newly diagnosed patients was $1,007. The lifetime cost of diabetes treatment (routine care and treatment of complications) was $3,400 higher with screening ($49,600 vs. $46,200). The cost per life-year gained was $236,400, and the cost per quality-adjusted life-year (QALY) gained was $56,600 (Table 3). Greater benefits and more favorable cost-effectiveness ratios were found if screening was conducted for younger compared with older people (because younger people lived longer with diabetes and had great reductions in lifetime complications) and for African-Americans

compared with the general population (primarily because of the higher complication rates among African-Americans).

Compared with other interventions for diabetes (e.g., intensive glycemic control, blood pressure and lipid management, and detection and treatment of diabetic retinopathy and nephropathy), screening for diabetes is not as cost-effective (170). Among type 2 diabetic patients, intensive glycemic control costs $16,000 per QALY (172), tight blood pressure control costs $700 per additional life-year (173), improved lipid control with statins costs $2,100 per QALY (174), detecting and treating diabetic retinopathy costs $3,190 per QALY (175), and treatment with ACE inhibitors to delay progression of kidney disease is cost-saving (176). However, when compared with screening for other conditions, diabetes screening is less favorable than some and more favorable than others. For example, detecting mild thyroid failure in persons aged 35 years during a periodic health examination costs $9,000 per QALY for women and $23,000 per QALY for men (176a). Screening and treating persons with no cardiac history with statins ranges from $54,000 per QALY to $1,400,000 per QALY, depending on age, sex, and the level of LDL (176b). Screening for breast, colon, and cervical cancers, respectively, have been estimated at $150,000 per QALY (annual mammography for women 50-65 years of age), $16,000 per QALY (FOBT screening for persons 50-75 years of age), and $16,000 per QALY (pap smear every 4 years for women 20-75 years of age; for every year the figure is (greater than)$1,600,000/QALY) (176c). Expert consensus from reviews of guidelines and cost-effectiveness studies of interventions for various diseases suggest that interventions having cost-effectiveness ratios less than $20,000 per QALY should be readily adopted and that those having ratios between $20,000 and $100,000 per QALY are usually provided, even though availability may be somewhat limited. Those interventions that have cost-effectiveness ratios greater than $100,000 per QALY have weak evidence for adoption (177).

How diabetes screening complements efforts to control other diseases should also be considered. Screening for diabetes can be combined with efforts to detect other conditions, such as hypertension and dyslipidemia (9,40). The mix of screening tests that produce the most benefit at the lowest cost could thus be determined (40,68,178). However, even though conditions or behaviors that accelerate diabetic complications (such as hypertension, dyslipidemia, or smoking) might also be detected at diabetes screening (40), these conditions can be detected without diabetes screening. Furthermore, directly screening for, identifying, and treating these other conditions in the population may be more efficient (9). Although measurement of fasting glucose is recommended as part of the evaluation of patients with diagnosed hypertension and lipid disorders because knowledge of diabetic status helps to determine treatment targets and to guide appropriate drug therapy (77c, 178a). Thus, examination of studies that might suppo rt diabetes screening should primarily consider the benefit gained from improved glycemic control until there is additional evidence that knowledge of diabetes actually leads to more aggressive cardiovascular risk reduction and that this risk reduction is itself cost-effective in asymptomatic patients with diabetes.

For a health care system to implement diabetes screening, it must obtain new resources or direct resources away from other activities. Because health care budgets are finite, redirection is more common thus, there is an "opportunity" cost in taking on a new activity (i.e., other activities may have to be reduced or eliminated) (178). Health care policy leaders need to assess the current situations and priorities to determine how diabetes screening should take precedence. Cost-effectiveness studies can help, but the absolute cost of the effort must be considered.

In summary both population-based and selective community screenings consume considerable resources and are unlikely to have a positive long-term impact on health. Opportunistic screening consumes fewer resources and provides better follow-up, but there is little empirical information about the benefits of such screening within current health care

systems. Computer simulation modeling suggests that clinic-based opportunistic screening is less cost-effective than other diabetes interventions but is in the range of other screening procedures recommended for several other conditions.

Questions 7: Will screening be a systematic ongoing process?

The answer to question 7 is probably not, at least not as currently conducted. Screening inevitably misses some individuals with disease (sensitivity (less than)100%) because many people do not present themselves for screening, and incident cases replenish the pool of undiagnosed cases. Thus, to fully address the problem of undiagnosed disease, screening programs must be ongoing. For ongoing screening to occur, there must be a commitment to develop and sustain screening activities, which, for community screening, include program coordination, support, and evaluation. If opportunistic screening is made part of routine preventive care, screening could be conducted in clinical settings at designated **intervals**. If conducted outside of usual clinical care, the logistical barriers are more substantial. In addition, the optimal time **interval** between screenings is not clear. Few studies have examined the appropriate frequency of screening. In one U.K. study (179), repeat diabetes screening was performed at 30 months using self-testing of postprandial glycosuria in 3,200 patients registered at a general clinic. The repeat screening response rate was slightly lower than the initial response rate (73 vs. 79%, P (less than) 0.0001), but the yield was not significantly different (0.44 vs. 0.72%, P = 0.2). The optimal **interval** between screenings is one at which the prevalence of undiagnosed cases reaches the prevalence of such cases at the previous screening, and the cost-effectiveness is the same for each screening. Thus, several unresolved issues remain as to how to ensure periodic screening and how often screening should occur.

THE YIELD OF DIABETES SCREENING PROGRAMS -- Evaluations of diabetes screening programs have focused on the programs abilities to detect undiagnosed cases. Published results of these evaluations listed according to the type of program used are presented in Table 5. Classification of the studies is based on the information from each report and an assessment of what appeared to be the dominant mode of the screening used.

Many screening programs have combined population-based and selective screening strategies (Table 5). Some programs, for example, began with population-based health promotion and diabetes awareness programs that targeted entire communities and then screened volunteers with diabetes risk factors. Testing strategies have included questionnaires and fasting, **random**, postprandial, and glucose-loaded biochemical measurements. Some programs have conducted public awareness campaigns that have resulted in increased patient requests for screening when making visits to health care providers (180), whereas others have advocated increasing professional awareness (166). The yields are highly variable and dependent on the screening test cutoff point. They have ranged from 4 to 72%.

Selective screening has occurred in a wide variety of settings, such as hospital and clinic waiting rooms (181), doctors offices and medical clinics (182), dental clinics (183), pharmacies (184), shopping centers (185), community centers (185), driver's license registration centers (186), worksites, and churches (187). Groups with rates of diabetes higher than the general population have been targeted using known risk factors for disease, such as older age, family history of diabetes, and obesity (186,188). Yields for selective screening have ranged from 5 to 40%.

The only rigorous study of the effectiveness of screening, which used simulation models (and is subject to limitations of this method), used an opportunistic screening approach (77). Few actual programs have used such an approach. Those programs involve such approaches as the sponsorship by health insurance companies of multichannel chemistry screening through widespread phlebotomy centers (167) and the use of clinic registries (106).

The yields of opportunistic programs ranged from 17 to 28%.

SCREENING PRACTICES, POLICIES, AND RECOMMENDATIONS -- In the U.S., some of the first organized diabetes screening was conducted among insurance applicants during the early 1900s (189). Later, during World Wars I and II, diabetes screening was conducted among enrollees in the armed services. The development of automated glucose measurement techniques led to even more widespread screening (189). Despite rather broad implementation, little was known about what these efforts accomplished.

Qualitative assessments of diabetes screening test performances in the U.S. during the 1950s found high false-positive and false-negative rates (189), but a call for the evaluation of diabetes screening efforts did not occur until the 1970s (190). In the 1970s and 1980s, problems were noted with indiscriminate mass screening, and the **value** of such initiatives was questioned (183,191-193). Two of the major issues concerned the criteria for a positive screening test and the need for standardized diagnostic criteria for diabetes. Diagnostic criteria were more firmly established in the early and mid-1980s (99,194). In the late 1980s and early 1990s, after widespread acceptance of standard diagnostic criteria for diabetes and reports that as much as half of the total diabetes burden was undiagnosed, some health organizations began to recommend screening.

Currently several health agencies, task forces, and professional organizations have published recommendations for screening for type 2 diabetes (Table 6) (70,101,195-197). Some of the recommendations were published several years ago, but none have been revised since the publication of the results of the UKPDS (71) or the cost-effectiveness simulation model (77). The most recent ADA recommendations were included in the report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (15). The preliminary WHO report on the diagnosis and classification of diabetes did not address screening (13).

Because definitive studies on the benefits of screening have not been available, all of the recommendations have relied on epidemiologic and other indirect evidence, expert opinion and consensus. None of the studies encourage population-based screening. Some suggest a selective or opportunistic approach in populations with diabetes risk factors. The WHO, the British Diabetic Association, and the ADA all provide screening strategies and recommend repeat-screening **intervals**. None of the strategies have been formally evaluated.

The current recommendations of the U.S. Preventive Services Task Force (USPSTF), which were published in 1996 and endorsed by the American Medical Association (198), cite insufficient evidence to recommend for or against routine screening (70). Major limitations cited by the USPSTF are the lack of practical screening tests that are sufficiently sensitive and specific and insufficient evidence that detection during the preclinical phase will improve long-term outcomes. Because evidence of benefit from early detection was not available, however, the USPSTF suggests that clinicians may nevertheless decide to screen high-risk individuals on other grounds and for the potential, albeit unproven, benefit that early treatment may provide. The report suggested that if the IJKPDS demonstrated important clinical benefits from more intensive interventions in patients with minimally symptomatic diabetes (a subgroup study from the UKPDS that has not been performed as yet), then UKPDS data may provide support for screening in asymptomatic adults. The USPSTF recommendations are currently under revision.

The current ADA recommendations (101), which were published in 1998, state that early detection and thus early treatment may reduce the burden of diabetes and its complications; accordingly, screening may be appropriate in certain circumstances. The ADA suggests that screening be considered at any age if risk factors for diabetes (i.e., family history; obesity; belonging to high-risk racial or ethnic group; history of abnormal glucose tolerance, hypertension, hyperlipidemia, or gestational diabetes; or delivery of a baby weighting (greater than)4 kg) are present. In addition, the ADA recommends screening all individuals (greater than)45

years of age, regardless of their risk factor status. It also recommends repeat screening at 3-year **intervals**. The rationales for this recommendation are that the incidence of type 2 diabetes increases sharply after age 45 years, the likelihood of developing any significant complications of diabetes within 3 years of a negative test is negligible, and the risk factors include d in ADA's recommendations are firmly established.

In light of these recommendations, just how common is screening for type 2 diabetes? Little information describing the level of screening is available. A 1989 U.S. population-based survey found that (sim)40% of individuals who did not have diabetes reported being tested for the disease during the previous year by a doctor or other health professional (157). Unfortunately, this report did not describe the location or the circumstances of the testing. In 1998, a population-based survey in Montana found that 39% of individuals without diabetes had been screened during the previous year (199). Several health organizations and agencies recommend diabetes screening, and screening is undoubtedly taking place, but it seems unlikely that it is being systematically applied and left up to patients, health care providers, and public health workers. A good deal of "accidental" diabetes screening may be occurring in the health care setting because the widespread use of multichannel chemistry tests means that glucose is fr equently measured from laboratory tests conducted for other reasons.

SUMMARY--Definitive studies of the effectiveness of screening for type 2 diabetes are currently not available. RCTs would be the best means to assess effectiveness, but several barriers prevent these studies from being conducted. Prospective observational studies may characterize some of the benefits of screening by creating screened and unscreened groups for comparison. The availability of better data systems and health services research techniques will facilitate such comparisons. Unfortunately, the interpretation of the results of such studies is extremely problematic.

Several screening tests have been evaluated. Risk assessment questionnaires have generally performed poorly as stand-alone tests. Screening with biochemical tests performs better. Venous and capillary glucose measurements may perform more favorably than urinary glucose or (HbA.sub.1c) measurements, and measuring postprandial glucose levels may have advantages over measuring fasting levels. However, performance of all screening tests is dependent on the cutoff point selected. Unfortunately, there are no well-defined and validated cutoff points to define positive tests. A two-stage screening test strategy may assist with a more efficient use of resources, although such approaches have not been rigorously tested. The optimal **interval** for screening is unknown. Even though periodic, targeted, and opportunistic screening within the existing health care system seems to offer the greatest yield and likelihood of appropriate follow-up and treatment, much of the reported experience with screening appears to be episodi c poorly targeted community screening outside of the existing health care system.

Statistical models have helped to answer some of the key questions concerning areas in which there is lack of empirical data. Current models need to be refined with new clinical and epidemiological information, such as the UKPDS results (200). In addition, future models need to include better information on the natural history of the preclinical phase of diabetes. Data from ongoing clinical trials of screening and treatment of impaired glucose tolerance, such as the Diabetes Prevention Program, may eventually offer more direct evidence for early detection and treatment of asymptomatic hyperglycemia (201). It will be important to use comprehensive cardiovascular disease modules that assess the conjoint influence of glucose and cardiovascular risk factor reduction, information on QOL, and refined economic evaluations using common outcome measures (cost per life-year or QALY gained) (11,178,202-204). Such studies should consider all of the costs associated with a comprehensive screening program, including, at a minimum, the direct costs of screening, diagnostic testing,

and care for patients with diabetes detected through screening. Finally combinations of screening tests and different screening **intervals** should be evaluated within economic studies to allow selection of the optimal approach within the **financial** and resource limitations of the health care system.

CONCLUSIONS--The effectiveness of screening for diabetes has not been directly demonstrated. Indirect examination of the potential benefits of screening using data from observational studies, data on treatment effectiveness from RCTs, and data on disease progression from simulation models suggests that early detection of type 2 diabetes and improved glycemic control may modestly reduce the lifetime occurrence of microvascular disease. There is little convincing evidence that the incidence of macrovascular disease will be reduced by improved glycemic control alone, but it may be improved by more aggressive treatment of hypertension and hyperlipidemia. The physical, psychological, and social effects of screening and early diagnosis remain unclear. One cost-effectiveness study which was conducted using simulation models, assessed an approach that involved screening of individuals who had contact with the health care system for reasons other than diabetes evaluation. In general, such opportunistic screening of th e adult population is cost-prohibitive, although opportunistic screening of high-risk subgroups was in a cost range considered economically feasible by some health care systems. Also, targeted opportunistic screening appears as cost-effective as many other screening procedures that are considered appropriate in the U.S.

In conclusion, population-based and selective screening programs in community settings (outreach programs, health fairs, or shopping malls) have uniformly demonstrated low yield and poor follow-up. Such screening entails a substantial opportunity cost and, under most circumstances, does not represent a good use of resources and therefore cannot be recommended. Periodic screening of high-risk individuals as part of ongoing medical care may be warranted, understanding that the evidence is incomplete. Questions remain as to the optimal methods, cutoff points, and screening frequency As stated earlier, clinicians should continue to be vigilant in recognizing clinical situations with a history, sign, or symptom suggestive of diabetes that warrant testing.

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This paper was peer-reviewed, modified, and approved by the Professional Practice Committee, June 2000.

Abbreviations: ADA, American Diabetes Association; DCCT, Diabetes Control and Complications Trial; ESRD, end-stage renal disease; OGTT, oral glucose tolerance test; PPV, positive predictive **value**; QALY, quality-adjusted life-year; QOL, quality of life; ROC, receiver operating characteristic; RCT, randomized control trial; UKPDS, U.K. Prospective Diabetes Study; USPSTF, U.S. Preventive Services Task Force; WHO, World Health Organization.

A table elsewhere in this issue shows conventional and Systeme International (SI) units and conversion factors for many substances.

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Criteria for the diagnosis of diabetes

Symptoms of diabetes (*) and a casual (+) plasma glucose level (greater than or equal to)200 mg/dl (11.1 mmol/1) Fasting plasma glucose level (greater than or equal to)126 mg/dl (7.0 mmol/l)

2-h plasma glucose on an OGTT (greater than or equal to)200 mg/dl

(11.1 mmol/l)
Only one criterion has to be met. The test must be repeated and remain positive on a separate day except when symptoms of unequivocal hyperglycemia with acute metabolic decompensation are present.
(*.) Polyuria polydipsia, and unexplained weight loss;
(+.) any time during day without regard to the time since the last meal. From the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (15).

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Publisher Name: American Diabetes Association
Event Names: *310 (Science & research)
Geographic Names: *1USA (United States)
Product Names: *8000212 (Diabetes R&D)
SIC Codes: 8730 (Research and Testing Services)
NAICS Codes: 54171 (Research and Development in the Physical, Engineering, and Life Sciences)

30/9/17 (Item 17 from file: 15)
02133444 69559086
The inflation-hedging characteristics of real estate and financial assets in Singapore

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Journal of Real Estate Portfolio Management v6n4 pp: 373-385
Oct-Dec 2000
ISSN: 1083-5547 Journal Code: JREP
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 13 Pages
Special Feature: Formula Graph Table
Word Count: 6464

Abstract:

This study empirically tests the inflation hedging characteristics of real estate and **financial** assets in Singapore. The results show that real estate provides a better hedge against inflation than does stock and securitized real estate. Industrial property is the most effective hedge against both expected and unexpected inflation, whereas shop offers only significant hedge against the expected inflation. The returns of the two assets establish more than one-to-one correspondence relationships with inflation. When the inflation hedging characteristics of assets are tested in different inflation environments, residential property hedges effectively against unexpected inflation in the low inflation regime, whereas the hedging performance of industrial property against both types of inflation is better in the high inflation regime.

Text:

Executive Summary. This study empirically tests the inflation hedging characteristics of real estate and **financial** assets in

Singapore. The results show that real estate provides a better hedge against inflation than does stock and securitized real estate. Industrial property is the most effective hedge against both expected and unexpected inflation, whereas shop offers only significant hedge against the expected inflation. The returns of the two assets establish more than one-to-one correspondence relationships with inflation. When the inflation hedging characteristics of assets are tested in different inflation environments, residential property hedges effectively against unexpected inflation in the low inflation regime, whereas the hedging performance of industrial property against both types of inflation is better in the high inflation regime.

Introduction

The inflation rate in Singapore as indicated by the Consumer Price Index (CPI) has been relatively stable over the last ten years. Its rate of increase has been hovering around 2% per year, which is one of the lowest in the world. For investors who hold assets for long-term returns, inflation risk is always of great concern because high inflation erodes the real returns accruable to them in the future. On this account, assets that are inflation-- hedges appear to be more attractive than those that are not. Traditionally, real estate has been regarded as one of the best inflation hedges. In a land scarce country like Singapore, it is believed that the prices of real estate would indefinitely rise in the long term due to inelastic and limited supply of land resources. As such, real estate has been accepted as an attractive alternative to traditional investments such as stocks, government and corporate bonds, and Treasury bills.

There is limited empirical evidence published on the inflation hedging characteristics of the real estate returns in Singapore vis-a-vis the overseas studies on the same topic. This study, therefore, aims to fill the empirical gap by examining the extent and effectiveness of the real estate returns in hedging inflation in Singapore. The empirical study tests the inflation-hedging features of a wide range of real estate (all-property, shop, office, residential and industrial real estate) and **financial** assets (all-share and all-property share) over a twenty-one-year period from 1978:1 to 1998:4. Based on the classical framework of Fama and Schwert (1977), this study tests the assets' hedging characteristics against three types of inflation: observed, expected and unexpected. Low Durbin-- Watson statistics are observed when regressing asset returns on inflation variables using the standard least square regression technique. These serial correlation problems1 are explicitly diagnosed in the proposed regression models that incorporate k-lag autoregressive error terms.

Two subperiod analyses are also carried out. The first subperiod **analysis** divides sample periods into four five-yearly subperiods and examines the inter-temporal changes of the inflation hedging characteristics of the assets. In the second subperiod **analysis**, we sort the sample periods into low and high inflation regimes and test the responses of assets returns to inflation in the two regimes. It is hoped that the research findings will help investors better understand the inflation-hedging characteristics of the different assets over different time periods and different inflation regimes when making their investment decisions.

This article is organized as follows. The next section reviews the past empirical studies on inflation-hedging characteristics of real estate and **financial** assets. The following sections provide an overview of inflation in Singapore for the past twenty years, the theoretical framework and the proposed empirical methodology, the data source, estimation of different inflation components, and specifications of empirical models for

the inflation-- hedging tests. The empirical results based on the inputs of asset returns and inflation data for a twenty-one year period from 1978 to 1999 are then analyzed. The final section is the conclusion.

Literature Review

The empirical framework proposed by Fama and Schwert (1977) has been widely adopted to test the inflation hedging ability of different assets in different countries. The results obtained in the empirical tests were, however, mixed and varied. By classifying the studies according to the asset types, the findings of selected studies are reviewed in this section.

Real estate has long been regarded as a good hedge2 against inflation. Empirical evidences obtained from country-specific and/or cross-country studies have been supportive of the hypothesis that real estate returns move in one-to-one correspondence with inflation rates. For the real estate market in the United States, the evidence of positive hedges against inflation in particular the expected inflation has been consistent (Fama and Schwert, 1977; Brueggeman, Chen and Thibodeau, 1984; Hartzell, Hekman and Miles, 1987; Coleman, Hudson-Wilson and Webb, 1994; Liu, Hartzell and Hoesli, 1997; and Wurtzebach, Mueller and Machi, 1991). The findings on the unexpected inflation were, however, less conclusive. Wurtzebach, Muller and Machi (1991) found that office and industrial real estate returns showed no significant hedge against unexpected inflation. The low inflation in 1980s was identified as one of the factors that had contributed to the insignificant real estate performance against unexpected inflation. In the United Kingdom, real estate also provided good protection against inflation (Limmack and Ward, 1988; Liu, Hartzell and Hoesli, 1997; Hoesli, MacGregor, Matysiak and Nanthakumaran, 1997; Miles, 1996; and Matysiak, Hoesli, MacGregor and Nanthakumaran, 1996). For unexpected inflation, Limmack and Ward (1988) found that office and shop offer no significant hedge, whereas Hoesli, MacGregor, Matysiak and Nanthakumaran (1997) showed that the unexpected inflation was not hedged by income, but was significantly hedged by the capital returns of real estate. The results are not dissimilar for studies in countries like Switzerland (Hoesli, 1994; and Liu, Hartzell and Hoesli, 1997), Canada (Newell, 1995), New Zealand (Newell and Boyd, 1995), Australia (Newell, 1996) and Hong Kong (Ganesan and Chiang, 1998).

On stocks, the empirical results of the studies in the U.S. in general supported the hypothesis that stock offers no significant hedge against inflation (Fama and Schwert, 1977; Hartzell, Hekman and Miles, 1987; Rubens, Bond and Webb, 1989; Coleman, Hudson-Wilson and Webb, 1994; and Gultekin, 1983). Liu, Hartzell and Hoesli (1997) obtained the same findings for stocks in the U.K. In another independent study by Hoesli, MacGregor, Matysiak and Nanthakumaran (1997), it was also shown that the capital returns of stock did not provide a hedge, but the income of the stock did significantly hedge a ainst the inflation. The findings by Hoesli (1994) and Liu, Hartzell and Hoesli (1997) also rejected the hypothesis that Swiss stock is a good inflation hedge. The findings by Newell (1996) and Liu, Hartzell and Hoesli (1997) on the Australian stock markets were contradictory. For the New Zealand (Newell and Boyd, 1995) and Hong Kong (Ganesan and Chiang, 1998) stock markets, there were perverse hedges against unexpected inflation, whereas in Canada, the stock return was insignificantly related to the expected inflation (Newell, 1995). For the inflation hedging behaviors of real estate stocks or the equivalent of the real estate investment trusts (REITs), the findings in countries like the U.S. (Liu, Hartzell and Hoesli, 1997), the U.K. (Hoesli, MacGregor, Matysiak and Nanthakumaran, 1997; and Liu, Hartzell and Hoesli, 1997), Switzerland (Hoesli, 1994; and Liu, Hartzell and Hoesli, 1997) and Australia (Newell, 1996; and Liu, Hartzell and Hoesli, 1997), showed no significant hedge against inflation. In Hong Kong, the empirical results of Ganesan and Chiang (1998) showed that stock had a partial hedge against expected inflation, but a perverse hedge against unexpected inflation.

For the bond markets, it was also generally accepted that bonds offer no significant hedge against inflation in countries like the U.S. (Hartzell, Hekman and Miles, 1987; and Coleman, Hudson-Wilson and Webb, 1994), the U.K. (Hoesli, MacGregor, Matysiak and Nanthakumaran, 1997), Canada (Newell, 1995), New Zealand (Newell and Boyd, 1995) and Australia (Newell, 1996).

Based on the literature cited, we can generalize the findings on the inflation hedging characteristics of the four main asset classes. Real estate was found to offer a significant hedge against inflation particularly the expected inflation in most of the countries. The hedge against unexpected inflation was not significantly shown by the real estate returns. For stocks, real estate stocks and bonds, we found no hedge against inflation in most of the countries, although minor variations were observed in some of the tests. Therefore, our general perception that real estate provides good protection against the erosion of purchasing power is not empirically unfounded. The subject of the inflation hedging of assets has been widely studied in other countries, particularly in the U.S. and the U.K. In

Singapore, there is no published empirical finding thus far on the inflation-hedging characteristics of various investment assets. The present study aims, therefore, to provide empirical evidence on this subject.

Inflation Rate Movement in Singapore from 1978 to 1998

Singapore has been very successful in its efforts to contain inflation. Between 1978 and 1998, the average inflation rate (i.e., changes in CPI) was as low as 0.62% per quarter or an equivalent of 2.48% on an annualized basis. The **historical** movements of inflation rates are shown in Exhibit 1. The late 1970s and the early 1980s were periods experiencing high inflation due mainly to the fluctuation in oil prices. The second oil crisis in 1979 escalated the inflation rate to 3.64% or 14.56% on an annualized basis in 1979:3. The uncertainty in the oil prices and the pressure of wage increases in the early 1980 had kept the inflation rate high at around 2.32% per quarter between 1979:3 and 1980:3. The inflationary pressure only began to ease in the 1982, which saw the largest decrease in inflation by 1.15% in 1982:3.

The contraction of the economic outputs since 1982 as a result of the slowdown in the world demand brought Singapore's economy into the first postindependence recession in 1985, which saw a negative GDP growth of 1.6%. A string of cost and taxcutting measures were implemented to boost exports and to restore the international competitiveness of Singapore's economy. The average quarterly CPI's rate of change was subdued at 0.12% between 1985:1 and 1989:1 as a result of the cost cutting measures.

The 1990s were a period characterized by stable inflation and rapid output growth. The inflation rates have been kept within a narrow quarterly band of 1.44% (1995:3 = 0.06% and 1990:4 = 1.50%) before the major Asian's **financial** crisis in July 1997. Singapore's economy was not spared from the **financial** crisis, and it suffered a 4.12% quarterly contraction in output in 1998:1. The inflation rate in 1998:1 also declined by 0.67%. The output contraction was aggravated by the concerns of a deflationary spiral in the economy, where firms and households hold back their investments and consumptions in anticipation of further declines in prices. The weak demand in real estate market led to four consecutive declines of 8.21% to 13.01% in the quarterly real estate prices in 1998. The CPI also registered negative growth rates for three consecutive quarters in 1998. The **historical analysis** of the inflation rate movement helps to shed lights on the effects of inflation on the hedging performance of different assets.

Empirical Methodology

Theoretical Framework

Fischer (1930) defines inflation as a phenomenon whereby there is a sustained and inordinate increase in the general price level. Inflation hedge, on the other hand, is a protection against the risk of losing the purchasing power as a result of the rising price of a good. An asset is an inflation hedge if and only if its real return is independent of the rate of inflation (Fischer, 1930). Fama and Schwert (1977) provide an operational definition that is widely used in the empirical tests of an inflation-- hedging hypothesis. According to the definition, an asset is said to be a complete hedge against inflation, if and only if the nominal return of the asset varies in a one-to-one relationship with both expected and unexpected inflation.

Theoretically, the expected nominal rate of return of an asset is composed of three components: expected real rate of return, expected inflation and unexpected inflation, which is represented as follows: where alpha

sub j
, beta

sub j

and gamma

sub j

are the regression coefficients and cj is the **random** error term. The hypothesis of the inflation-hedging tests is set such that if the null hypothesis: beta

sub j

= gamma

sub j

= 1.0 could not be rejected, the regression coefficients, beta

sub j

and gamma
sub j

are statistically indistinguishable from 1.0. The asset is then said to be a complete hedge against inflation. In other words, the expected nominal return of the asset varies in one-to-one correspondence with both the expected and unexpected inflation. The signs of the regression coefficient indicate whether an asset is a positive hedge or a negative hedge against inflation. An asset offers a partial hedge against the respective inflation if the coefficient is found to be less than 1.0, but statistically distinguishable from 0. For an asset that has a coefficient that is statistically higher than 1.0, the asset hedges against not only the inflation on a one-to-- one basis, it also offers additional hedge against the inflation risks of other assets in the **portfolio**.

Data Sources

The data employed in this study comprise the Urban Redevelopment

Authority's (URA) All-- Property Price Index and the related subindices: the Residential Property Price Index, the Office Property Price Index, the Retail Property Price Index and the Industrial Property Price Index, the Stock Exchange of Singapore's (SES) All-share Index, the SES All-property Share Index, the CPI and the three-month Treasury bill rates. The 1978 to 1998 Treasury bill rate data are available in the Monetary of Authority's Quarterly Statistical Bulletin, whereas all other data are obtained from the TRENDS database of the Statistic Department of Singapore. To be consistent with other property indices, quarterly series of the CPI, the Treasury bill rates and the stock indices are used.

The URA is the government agency of Singapore, which compiles the property price indices based on the actual transactions lodged as caveats with the Registry of Titles and Deeds.[3] The Price Index covers five major types of private real estate, which include residential, office, shop, flatted factory (industrial) and warehouse.[4] The all-property price index is constructed from the weighted average of the sub-indices, where the composition of different sub-sector indices is kept constant over a base year. The subsector indices are derived based on the median prices of transactions selected from different planning areas. The indices are not subject to smoothing problems, which are inherent in many appraisal-based indices. The SES All-share Index represents the price movement of all listed Singapore incorporated and Singapore-currency traded companies on the Stock Exchange of Singapore. The SES has also compiled six sub-indices categorized by industrial type. The SES All-- Property Price Index is the closest proxy for benchmarking the performance of the securitized real estate assets. The nominal asset returns (R_j) are calculated as the first difference of the log-prices of the assets, i.e., $R_{jt} = \ln (P_{jt}/P_{jt-1})$.

Measures of Inflation Rates

The two most commonly used measures of inflation are the CPI, or the retail price index in some countries, and the gross domestic product (GDP) deflator. The CPI is a Laspeye-based index where the average inter-temporal changes in prices are measured on a fixed basket of goods and services consumed by households surveyed in a based year.[5] The GDP deflator, on the other hand, is a relative measure of the aggregate net output or the valueadded of the economy between the current year and the base year. The GDP deflator measures a wider range of goods and services, and the output base is more susceptible to a structural change in the economy.

In our study, the CPI is used as a proxy of the inflation rate. The actual rate of inflation (Δ_t

) is computed as a simple difference in the price level over the price in the previous period, which is given as:

Expected inflation, as the name implies, is a rate that is formulated based on an individual expectation and the information that is available in the previous period (t - 1). It captures the expected changes in the purchasing power at the beginning of the period (Hamelink, Hoesli and McGregor, 1997). Unexpected inflation, on the other hand, reflects the **random** errors observed between the actual and the expected inflation. The error terms are caused by inefficiency in the market where not all the past information has been processed by the market. There are different approaches proposed to represent the expected and unexpected inflation (e.g., Fama and Gibbons, 1982; Gultekin, 1983; Hartzell, Hekman and Miles, 1987; Limmack and Ward, 1988; and Harvey, 1989). Following the approach proposed by Fama and Schwert (1977), the expected inflation in our **analysis** is directly represented by a one-period lagged three-month Treasury bill rate.
For the unexpected inflation (U

sub jt

), we follow the approach of Fama and Schwert (1977) by determining the unexpected inflation as the difference between the actual inflation and expected inflation, i.e., U

sub jt

= [Delta

sub t

- Epsilon(Delta(overscored)

sub t

|phi

sub t-1

], where Delta
sub t

is the actual inflation and Epsilon(Delta(overscored)

sub t

|phi

sub t-1

) is the three-month Treasury bill rate fixed in the previous period.

Descriptive Statistics for Asset Returns and Inflation Rate

Exhibit 2 shows the **historical** statistics of asset returns and inflation rates for the sample period. The results show that real estate assets in general did better than both stocks and securitized real estate (i.e., real estate stocks) in terms of their mean quarterly returns. Residential property is the best performer with the highest mean quarterly return of 2.48%, whereas the performance of stocks was the worst among the asset classes with a mean return of 0.07%. The nominal rates of return of office (2.08%), industrial (1.94%) and shop (0.87%) performed below the

mean real estate market return (all-property) of 2.24%. However, all the real estate assets outperform the actual mean rate of inflation of 0.62%, which indicates that the real returns for all real estate assets are positive. In comparison, the quarterly mean returns of both stock and securitized real estate (0.23%) performed below the actual rate of inflation.

On the risk side, the SES all-property stock returns has the highest standard deviation of 22.42%, followed by the standard deviations of allstock at 17.91%. Real estate assets have a comparatively lower standard deviation of not exceeding 10.33% (office) across all sectors. It, therefore, appears that real estate assets are more attractive both in terms of mean returns and standard deviations, vis-a-vis stocks and securitized real estate.

The Pearson rank correlation coefficients between the returns of different asset classes and actual inflation are summarized in the last column of Exhibit 2. The coefficients are all positive and significant at the 5% level with the exception of the SES all-share return. Real estate in general moves closely with the changes in inflation. The URA All-- property Index has the highest correlation coefficient of 0.486 with the inflation, and it follows in a descending order by industrial (0.453), residential (0.444), office (0.406) and shop (0.222). The correlation between the securitized real estate and inflation is also significant, but with a smaller coefficient of 0.217. The Pearson rank correlation coefficients for the SES all-share is insignificant at the 5% level.
Empirical Model Specifications

In the Fischer's hypothesis, the expected nominal rate of return is the sum of the expected real rate of return and the expected inflation. If the market is efficient, the expected real return should be independent of the expected inflation. Based on this assumption, Fama and Schwert (1977) develop the following testable empirical model specification, which includes an unexpected inflation component:

The unexpected inflation component is included to take account of the unanticipated shocks when the market cannot respond efficient enough to new market information. As the t-period actual inflation is the sum of the expected and unexpected inflation at time t, i.e., Delta

sub t

= Epsilon(Delta(overscored)

sub t

|phi

sub t-1
) + Upsilon

sub t

, we test

Analysis of Results

Hedging Against Actual Inflation

The regression given by Equation (5) tests the hedging ability of assets against actual inflation (see Exhibit 3). The regression coefficients of the actual inflation variable, delta

sub j

, are all positive, but only two of the regression coefficients: shop and industrial property, are statistically significant at 5% level. Residential property return has the lowest delta

sub j

coefficient of 0.609 while the SES all-- property share return has the highest coefficient of 5.186. Although the inflation coefficients of the stock market models-all-share and all-property share-are higher compared to the real estate models, they are not statistically significant. In other words, the securitized assets are not good hedges against actual inflation. The regression results reject the inflation-hedging hypothesis for all the assets except for shop and industrial property. Shop (delta

sub j

= 2.863) and industrial property (delta

sub j

= 2.813) returns provide more than a perfect hedge against actual inflation, and their returns hedge more than one-to-one corresponding variations in the actual inflation.

Hedging Against Expected and Unexpected Inflation

The tests of inflation hedging against expected and unexpected inflation are conducted by running the empirical model given by Equation (4). The results of the regressions as summarized in Exhibit 4 indicate that the coefficients for the expected inflation (beta

sub j
) and the unexpected inflation (gamma

sub j

) variables range from 0.524 to 5.694 and 0.635 to 7.431, respectively. Residential property return (beta

sub j

= 0.524 and gamma

sub j

= 0.635) has the lowest coefficients whereas all-property share return (beta

sub j

= 5.201 and gamma

sub j

= 5.301) have the highest coefficients. They are all not statistically significant at the 5% level. The results are overall consistent with those found in the tests against actual inflation. The securitized assets, despite the high coefficients, fail to reject the null hypothesis. Thus, they offer no hedge against both expected and unexpected inflation. Shop

and industrial property are two assets that provide significantly strong hedges against expected inflation (beta

sub PSHOP

= 2.443 and beta

sub PIND

= 2.938). Industrial property, besides hedging against the expected inflation, also provides more than a one-to-one corresponding hedge against the variation in the unexpected inflation.

Five-yearly Subperiod **Analysis**

In this subperiod **analysis**, the entire sample period of twenty-one years is divided into four subperiods consisting of a five-year **interval** for the first three sub-periods and a six-year **interval** for the last sub-period. This **analysis** is undertaken to uncover any hidden trend and also to further breakdown the inflation hedging characteristics of the property into smaller subintervals. For the ease of tabulation, we denote the period between 1978 and 1982 as "I;" the period between 1983 and 1987 as "II;" the period between 1988 and 1992 as "III;" and the period between 1993 and 1998 as "IV." The "goodness of fit" of the regression models as indicated by the Re values vary widely from 0.044 (Property) to 0.909 (Office). The Durbin--Watson statistics show no serial correlations since they have been fully eliminated through the autoregressive process. The number of lag used for the autoregressive error terms is about 3.

The subperiod inflation-hedging characteristics of different asset classes are revealed by the regression coefficients of the expected and unexpected inflation variables in Exhibit 5. The results show that industrial property is the only asset that offers consistent positive hedges against both expected and unexpected inflation. All other assets have mixed positive and negative coefficients over different subperiods. Subperiod IV appears to be the most significant period for hedging where two real estate (all-property and residential) and two non-real estate (all-stock and securitized property) assets are found to have significant positive hedges against expected and unexpected inflation. Subperiod III is the worst period for inflation hedging as none of the coefficients are statistically significant at the 5% level.

In subperiod I, industrial property (beta
sub j

= 4.499 and gamma

sub j

= 3.557) is the best choice for a **portfolio** that requires positive hedges against expected and unexpected inflation. Office property (beta

sub j

= 3.232) is also a good asset for hedging expected inflation during subperiod I, and its positive hedging ability is stronger in subperiod II with a coefficient of gamma

sub j

= 7.142 at the 5% significance level, but this time the hedging is effective against the unexpected inflation. Suberiod II was a highly volatile period where it experienced an economic recession with an output growth of -1.6% in 1985, and the 1987 black Monday crisis which tumbled the stock markets with a drastic 53.49% decline in the all-share indices in 1987:4.(7) These two systematic market risks have resulted in significant negative hedges by the returns of three asset types: shop (beta

sub j

= -8.709), all-share (beta

sub j

= -13.952) and unsecuritized real estate (beta

sub j

= -20.595), against the expected inflation at the 5% level of significance.

Subperiod III witnessed the recovery of the economy, but the rates of recovery in the asset prices were not able to catch up with the inflation rate changes. The results of the inflation-hedging tests for all the assets were not statistically significant for this period. In subperiod IV, securitized real estate returns provide the best inflation hedges against both expected (beta

sub j
= 32.954) and unexpected (gamma

sub j

= 39.089) inflation. A strong inflation hedging performance was also indicated by allstock returns (beta

sub j

= 25.315 and gamma

sub j

= 28.674) during this period. The strong upward momentum of the all-share and all-property share indices, which peaked with quarter-to-quarter returns of 15.95% and 28.88% respectively in 1993:4, coupled with the continuous stabilization of the inflation were two main factors that underpin the impressive hedging performance of the two **financial** assets in subperiod IV.

High and Low Inflation Period **Analysis**

The periods of high and low inflation were divided at the median of the inflation rates from 1978 to 1998. Sample periods with inflation above the median are classified into the high inflation group while those samples with inflation below the median are classified into the low inflation group. For the entire study period, forty-two periods are in the high inflation group while forty-one periods are in the low inflation group. Next, the same regression model specification given by Equation (4) was used to analyze the inflation hedging characteristics of the assets in these two subperiods.

By simply comparing the magnitudes of beta

sub j

and gamma

sub j

coefficients in Exhibit 6, it was shown that the inflation hedging performances of all the assets were generally better in the low inflation period than in the high inflation periods. All the statistical results were nevertheless insignificant at the 10% level, with the exception of office and residential returns. Office property indicated significant but negative relationships with respects to the expected (beta

sub j
= -20.058) and unexpected inflation (gamma

sub j

= -18.727). Residential property showed a strong hedge against unexpected inflation in the low inflation period, where a 1% increase in unexpected inflation leads to 14.84% increase in the nominal residential prices. Industrial property appeared to be the best choice for investors during the high inflation periods because its returns offer significant positive hedges of more than six times against expected inflation and more than eight times against unexpected inflation in these periods. For **financial** assets, the results are insignificant at the 10% level and the hypothesis of zero inflation hedging characteristics cannot be rejected in both high and low inflation regimes.

Inflation Hedging Performance and Implications

The results of inflation-hedging tests are summarized in Exhibit 7. The results do not reject the hypothesis that real estate assets are better hedges against inflation compared to **financial** assets. Over the entire sample period, real estate collectively in a weighted **portfolio** did not exhibit a strong hedge against inflation, but by sector, industrial and shop appeared to have significant hedges against expected inflation. Industrial property also hedged against unexpected inflation.

The empirical results seem to suggest that a **portfolio** with a higher exposure to industrial real estate is better able to protect against inflation risks than a standard asset **portfolio**. For institutional investors who have not included industrial property in their portfolios, it would be strategic to improve the hedging capability of the **portfolio** against inflation by increasing the industrial real estate weight. A **portfolio** strategy that pushes for a higher weight of industrial real estate holding is particularly significant in periods of high inflation. However, there are basically two barriers with regards to investment in industrial real estate. In Singapore, the industrial market is dominated by the public sector development agencies, where the industrial land and factory spaces are on leasehold basic and strict restrictions are imposed that make them unattractive for investors. There are limited stocks of private sector industrial property that are available for investment purposes. The specialized nature of industrial property is the second barrier that makes investment in the industrial market less appealing. The irreversibility cost of industrial real estate is relatively high due to the inflexibility in switching of use when demand is weak.

Shop is another real estate asset that offers a relatively strong hedge

against expected inflation. This sector is rather oligopolistic in nature as the majority of the prime shopping centers are developed and managed by institutional investors for long-term holding purposes. Economies of scale are another important factor that makes single ownership of a shopping center more favorable than a multi-ownership structure, because resources could be more optimally pooled to implement a crowd-pulling tenant-mix and marketing activities. Developers with substantial retail real estate in their **portfolio** holdings are in a better position to hedge against expected inflation. For small investors who do not have the **financial** muscle to invest in large scaled shopping centers, shophouses are another category of real estate that offers the same scope of inflation protection in Singapore.

Exhibit 7 shows that the inflation-hedging characteristics of the assets are not persistent over time. The results do not rule out the presence of time-varying risk premiums in the assets. The time variations in the expected returns of the U.S. securitized real estate assets were empirically predicted by Liu and Mei (1992) and Mei and Lee (1994) in the Generalized Method of Moments (GMM) framework. The GMM tests are, however, not within the scope of this study.

The Exhibit 8 reveals that expected inflation on a quarterly basis declined from 3.72% in subperiod I to 1.20% in subperiod IV. The quarterly unexpected inflation, in absolute terms, also declined from 3.40% to 1.11% for subperiods I and IV, respectively. During the high inflation in subperiods I, industrial and office were relatively effective in hedging off inflation risks that were fueled by oil price hikes. In subperiod IV when the inflation rate has been contained at a relatively stable rate, broader asset classes, which include real estate, residential property, stocks and real estate stocks, are available for institutional investors who place inflation-hedge as one of the main objectives.

Conclusion

Our study provides empirical evidence to verify the traditional belief that real estate is a good hedge against inflation. Using the empirical data of Singapore markets, the results did not reject the hypothesis that real estate is a good hedge against inflation. The inflation hedging performance of real estate in general is found to be better than the **financial** assets that include only stock and securitized real estate. Industrial property is found to be the most effective hedge against both expected and unexpected inflation, whereas shop offers a significant hedge only against expected inflation. The returns of the two real estate assets established not only perfect one-to-one correspondence relationships with the inflation rate, they also increased at a faster rate than the increase in the inflation rate. Therefore, industrial property and shop, when included in an investor's **portfolio**, provide sufficient hedge against their own inflation risks as well as the inflation risks of other assets in the **portfolio**.
The results of the five-yearly subperiod **analysis** showed that except for industrial property that offers consistent positive hedges against both expected and unexpected inflation, all other assets have a mixture of positive and negative coefficients over the different subperiods. It implies that an asset, which is a good hedge against inflation in one period, can become a negative inflation hedge in another period. The findings highlight the importance of the points of entry and/or exit of an investment when determining the effectiveness of the inflation-hedging characteristics of the assets. In the subperiod **analysis**, subperiod IV appears to be the most significant period for hedging inflation where two real estate assets (property and residential) and the all-stock and securitized real estate assets showed significant positive hedges against expected and unexpected inflation.

Suberiod III had the worst inflation hedging record, as none of the coefficients was statistically significant at the 5% level.

When the level of inflation is controlled in the **analysis** (i.e., by dividing the sample period into high and low inflation periods), it was found that more assets perform better in the low inflation period than in the high inflation period. Residential property showed a strong hedge against unexpected inflation in the low inflation period. However, the same proposition was not applicable for office property, the results of which indicated that office returns were significantly but negatively correlated with both the expected and unexpected inflation. Industrial property is the best choice for investors who wish to hedge against both expected and unexpected inflation in the high inflation regime. Its returns increase more than one-to-one with increases in the inflation.

For **financial** assets, namely stocks and securitized real estate (real estate stocks), the findings are consistent with the general perception that they offer insignificant hedges against inflation, with the exception of the subperiod IV. The SES Allshare and All-property Share Indices have produced excellent inflation-hedging records in the subperiod IV, as a result of the stock market boom and optimism, coupled with the stabilization of the inflation rates during the period. Therefore, in conclusion, we could not reject the hypothesis that real estate assets in Singapore are in general better hedges against inflation as compared to **financial** assets.

Exhibit 1

Exhibit 2

Exhibit 3

Exhibit 4

Exhibit 5
Exhibit 6

Exhibit 7

Exhibit 8

Endnotes

1. The serial correlation found in the regression of asset returns on inflation may suggest the presence of time-varying risk premiums, which have been tested by Liu and Mei (1992) and Mei and Lee (1994) using the Generalized Method of Moments (GMM) technique. The GMM tests of the effects of lagged inflation on asset returns and risk premiums are, however, not undertaken here.

2. Assets that have the ability to protect investors from the effects of inflation are generally labeled as inflation hedges.

3. Caveats are usually lodged with the Singapore Land Registry after an option to purchase a real estate is exercised or a sale and purchase agreement is signed. Caveats protect the interests of the purchaser against other claims on the real estate.

4. Warehouse is not included in this study due to the specialized nature of the real estate and also the relatively small quantity in supply that are offered for investment purposes.

5. The basket of goods and services comprises food, clothing, housing, transport and communication and miscellaneous, and it is kept fixed so that changes in the index reflect only price changes and not changes in the type of goods and services purchased.

6. The results of the preliminary analyses are not included but are available on request.

7. The all-property share index has also dropped by 19.48% in the fourth quarter of 1987.

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Geographic Names: Singapore

Descriptors: Studies; Real estate; Hedging; Rates of return; Inflation
Classification Codes: 9130 (CN=Experimental/Theoretical); 9179 (CN=Asia & the Pacific); 8360 (CN=Real estate); 3400 (CN=Investment analysis & personal finance)
Print Media ID: 34769

30/9/18 (Item 18 from file: 15)
02133441 69559076

The efficiency of equity REIT prices

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Journal of Real Estate Portfolio Management v6n4 pp: 349-354
Oct-Dec 2000
ISSN: 1083-5547 Journal Code: JREP
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 6 Pages

Special Feature: Table
Word Count: 3372

Abstract:

Given the broad array of investment vehicles that investors can choose from in today's **financial** and capital markets, the knowledge of the efficiency of asset prices and the relative price volatility is essential to informed decision making. The purpose of this research is to determine if real estate investment trust (REIT) prices have been efficient. In order to test the efficiency of REIT prices, two statistical tests were performed - a runs test and an autocorrelation test. The results of both tests suggest a degree of inefficiency in REIT prices.

Text:

Executive Summary. Given the broad array of investment vehicles that investors can choose from in today's **financial** and capital markets, the knowledge of the efficiency of asset prices and the relative price volatility is essential to informed decision making. The purpose of this research is to determine if real estate investment trust (REIT) prices have been efficient. In order to test the efficiency of REIT prices, two statistical tests were performed-a runs test and an autocorrelation test. The results of both tests suggest a degree of inefficiency in REIT prices.

Introduction

Equity real estate investment trusts (EREITs) are public companies that invest and manage portfolios of commercial property and whose stock is traded in one of the major stock exchanges. They provide individual and institutional investors interested in including real estate assets in their portfolios an alternative to direct investment in properties. The liquidity of EREIT shares is attractive to individual and institutional investors since it enhances their ability to make adjustments in their portfolios. During the 1990s, the liquidity of EREIT shares increased due to the growth in size and scope of the real estate securities market in general, and of the real estate equities in particular.1 As a result, EREIT shares are part of a broad array of investment vehicles available in the market today. Therefore, it is important that investors have access and knowledge about the efficiency of EREIT share prices.
The main implication of an efficient market is that investors are unable to consistently earn abnormally high rates in excess of expected market rates of return. The majority of investors are interested in "beating the market." Therefore, this research will examine whether EREITs within the equity market are efficiently priced.

One way of determining if an EREIT security is inefficiently priced is by examining whether EREIT price changes follow a deliberate pattern or are distributed **randomly** based on the **random** infusion of new information. Statistical tests can be performed to determine if EREIT security prices are indeed **random**.

Purpose

An efficient market is consistent with the **random** walk hypothesis since an efficient market is defined as a market in which security prices adjust rapidly to the announcement of new information about the firm so that current market prices fully reflect all available information regarding the security. In addition, a large number of

profitmaximizing individuals analyze and **value** securities acting independently of one another. Second, new information about the securities arrives in a **random** fashion. And, investors, reacting quickly to new information, cause security prices to change so they reflect the influence of all available information.
Further, there are three different forms of efficiency. The weak form efficient market suggests that current prices fully reflect all past information concerning the asset. The semi-strong form of efficiency states that security prices rapidly adjust to the infusion of new market information. And, the strong form suggests that current prices fully reflect all public and private information about a security.

This research attempts to determine if the EREIT market is efficient. In order to determine if it is, two statistical tests are performed-a runs test and an autocorrelation test. These tests have been traditionally used in efficient market studies to determine if security price changes are dependent or independent of each other. Independent price changes are consistent with the **random** walk and efficient market theories, whereas, dependent price changes would indicate inefficiently priced securities. Daily and monthly data are used. Two samples were created from the data. One sample includes monthly EREIT price data of 108 **randomly** selected EREITs and the other sample consists of daily REIT price data of 102 that were **randomly** selected.

Literature Review

The majority of previous studies on market efficiency focus on stock and bond price inefficiencies.
Most of these studies conclude that security price changes do follow a **random** walk pattern that is consistent with the efficient market hypothesis.

Fama (1965) empirically tested the **random** walk model of stock price behavior. The **random** walk model makes two assumptions.
First, successive price changes are independent. Second, price changes conform to some probability distribution. Of these two assumptions, Fama points out that the first one is the most critical because if successive price changes were not independent then the **random** walk theory would not be valid. The data Fama used consisted of daily prices for each of the thirty stocks of the Dow Jones Industrial Average, from the end of 1957 to September 26, 1962. Fama generated thirty samples with 1,200 to 1,700 observations per sample. Tests for serial correlation and a runs test were conducted on the data. He concluded that there was little evidence from the serial correlations and the runs tests to suggest any large degree of dependence between reported daily prices.

Fama (1970) reviewed the theories and empirical work done with respect to efficient capital markets. He explains, "There is consistent evidence of positive dependence in day-to-day price changes and returns on common stocks, and the dependence is of a form that can be used as the basis of marginally profitable trading rules. However, he points out that any trading system that attempts to turn short-term price dependence into trading profits generates so many transaction costs that their expected profits are more than absorbed by minimum transaction costs. Therefore, he argues that this slight positive dependence is not of sufficient importance to warrant rejection of the efficient market model. Obviously, day trading has altered this historic conclusion.

Hagerman and Richmond (1973) tested the independence implication of the **random** walk hypothesis of securities traded in the OTC market.
The reason for choosing the OTC market was that the companies listed had greater geographic dispersion that those on the NYSE. The authors conducted

a serial correlation test and concluded that price changes are serially independent in the OTC market and are consistent with the **random** walk hypothesis.

In addition, there have been a significant number of EREIT studies performed over the last ten years that have bearing on the question of efficiency. The majority of these studies examine the relationship between the risk and return of EREITs. While findings of these studies in some cases imply an inefficient EREIT market, no studies examine the specific theory of **random** walk as it applies to EREITs.

Giliberto (1990) examined the residuals from regression **analysis** of EREITs. His study found that the residuals of real estate return series on EREITs and real estate returns are significantly correlated, supporting the notion that there is a common factor(s) associated with real estate that affect both sets of returns. While correlations were not calculated over time for either series, this study might suggest that there is a relationship among prices from one category of real estate to another.

From a study of REIT market microstructure, Wang, Erickson, Gau and Chan (1992) postulate that the relationship of REIT returns and market attention actually have an indirect relationship. Their findings conclude that shares of REITs tend to have small turnover ratios, lower institutional investor participation and a smaller following among security analysts compared to other types of traditional stocks. Also, it is suggested by their research that REITs that are followed more closely tend to perform better than those REITs that are relatively obscure. This would suggest that the more scrutinized REM might tend to be more efficiently priced.

A further study by Goebel and Ma (1993) dealt with the perception that REITs trade at discounts from their net asset values and thereby suggest relative price inefficiencies. The authors perform a cointegration analyses that confirms a long-term, equilibrium relationship between REIT returns and their underlying fundamental **value**. Specifically, the authors further demonstrate that REITs, in this study, traded at approximately 77% of net asset values. Suggesting that there may be price inefficiencies in play at least for the given time period of the study (1972-1992).
In a more recent study by Hun and Liang (1995), the authors examine the long-term (1970-1993) performance of REITs and investigate the stability of REIT return performance over time. In addition, Hun and Liang investigate the sensitivity of a specific performance measure, the Jensen Index, to two general performance benchmarks and two REIT samples. Their results indicate that the performance of REIT portfolios was consistent with the security market line for the long-term period. Thereby suggesting that REM are efficiently priced in the long run.

Nelling and Gyourko (1998) examined the predictability of monthly returns on EREITs over the period 1975-1995 and compare that predictability with that for small and mid-cap firms. Using a time series approach, evidence is found that monthly EREIT returns are predictable based on past performance. This would suggest that the REIT market is inefficient. However, the authors are quick to point out that the predictability is not substantial enough to cover typical transaction costs, so that there is no evidence of unexploited arbitrage opportunities.

Methodologyand Data

The purpose of this study was to either support or refute the hypothesis that the EREIT market is efficient. If the EREIT market is efficient, security price changes should be independent over time due to the **random** nature of new information entering the market and thereby

affecting price changes. Traditionally, two types of statistical tests have been used to investigate whether security price changes are **random**. The first test is a runs test, which is a non-parametric test, and the second test is an autocorrelation test, which is a parametric test.

The runs test was performed using the monthly and daily price data. The runs test examines a series of price changes, and designates each change as a (+), (-) or (0). Positive price changes are designated by (+), negative changes by (-) and no change as (0). Thus, a possible result of the test might be: +++- - - - 00+++ - - -, which would represent five runs. A run occurs when consecutive positive or consecutive negative price changes occur more than once. When the price changes to a different sign, the run is completed and a new run is started. The expected number of runs in a **random** series is the equivalent of E = 1/3(2n - 1). Where E is the expected number of runs, and n is the number of observations.

If there are too many or too few runs in the price series, then the series is not a **random** series, and it would then be possible for investors to predict future prices by means of a trading rule. Too few runs may infer that security price changes respond rather slowly with regard to the infusion of new information in the market, whereas, too many runs may indicate that prices over adjust when new information is made available to investors.
In order to determine if the actual number of runs is significantly different than the expected number of runs, a p-**value** is calculated and compared to the alpha values used in the study. The p-**value** is the area of rejection in a statistical distribution, and it is the smallest **value** of alpha for which one can reject the hypothesis being tested. To disprove the **random** walk theory, the p-**value** would have to be less than the alpha **value** selected for the study. If the p-**value** is larger than the alpha **value**, the **random** walk theory holds. However, the opposite conclusion is reached if the p-**value** is less than the alpha **value**. For the purposes of this study, two alpha values were selected-05 and .01.

Using an alpha **value** of .05 indicates that on the average no more than 5% of the securities tested should have a p-**value** lower than .05 in order to substantiate the **random** walk hypothesis. If there is a much larger proportion than 5% of the securities having p-values lower than .05, the price changes are not **random** , and some degree of inefficiency exists. Using an alpha **value** of . 01 dictates that on the average no more than 1% of the securities tested should have a p -**value** lower than. 01.

Thus, price inefficiency can be assumed if significantly more than 1% of the securities tested have a p-**value** below .01.
If the test results indicate that the price series is independent or **random**, then the research hypothesis should be accepted, thus suggesting the efficient market hypothesis with regard to EREIT prices for the period studied. If the test results indicate that the price series is dependent or nonrandom, then the research hypothesis is rejected. The autocorrelation test was performed using the daily price data of the EREITs, and it tests for significant positive or negative autocorrelation in price changes over time by determining whether a price series is **random** through examining the autocorrelation function of the series of first differences in each security's price. This test will determine if the price change on day t is correlated with the price change on day t

sub -1

, t

sub -2

,t

sub -3

etc. through twenty-four time periods. Each of the time periods, also referred to as lags, will be analyzed for price correlations or dependence. Insignificant autocorrelations between all such lags will suggest price independence, and validate the **random** walk theory, and this research hypothesis. Whereas significant autocorrelations will suggest price dependence, and will refute both the **random** walk theory and this research hypothesis.

An autocorrelation for any given lag will be considered to be significant if the absolute **value** of the estimated autocorrelation **value** is at least twice as large as the standard error for the test (Box, 1970). Again, a significant autocorrelation with respect to any lag will indicate price dependence with respect to that security, and refute the **random** walk theory. If the absolute **value** of the estimated autocorrelation **value** is less for all lags, then price independence will be confirmed for that security, and the **random** walk theory will be accepted.

To test the efficiency of EREIT prices, daily and monthly samples are used. It was hypothesized that by using both monthly and daily price changes, market inefficiencies might be detected at different time **intervals**. The sample of monthly EREIT prices includes 108 **randomly** selected EREITs from January 1989 through October 1998 and allowed for 130 possible price observations for each security. The sample of daily REIT price consists of 102 **randomly** selected EREIT data from November 2, 1997 through February 1999, allowing for 324 possible price observations for each security. The data was obtained from price/return data supplied by COMPUSTAT data files, **Value** Line Investment Survey, Standard and Poors stock reports and various Internet sources such as the National Association of Real Estate Investment Trusts website.

Analysis of Data

A runs test was performed for both the monthly and daily REIT price data. The calculated p-**value** from the test were rounded to the nearest ten thousandth for each security.

For both the monthly and daily price data, significantly more than 5% of the securities tested have alpha levels below .05. With regard to the monthly data, roughly 75% of the securities tested have calculated p-values below .05, which would support an inefficient EREIT market. Approximately 63% of those securities tested have calculated p-values less than .05 (see Exhibit 1).

For both the monthly and daily price data, significantly more than 1% of the securities tested had alpha levels below .01. With regard to the monthly data, 68% of the securities tested had calculated pvalues below .01, which would again support an inefficient EREIT market. Furthermore, the daily data sample also supports an inefficient EREIT market since approximately 55% of those securities tested have calculated p-values less than .01.

In summary, at both alpha levels of .05 and .01, there are a significant number of EREITs with unexpectedly low calculated p-values that support the idea that REIT markets, may at times, be inefficient.

In addition, an autocorrelation test was conducted for the daily EREIT sample (see Exhibit 2). A security was considered to be price dependent (inefficiently priced) if that security's autocorrelation indicated a significant price dependency in any of the twenty-four lags tested with regard to that security. If the absolute **value** of the estimated autocorrelation **value** is at least twice as large as the standard error of the test for any lag, then that security will demonstrate significant price dependency. Of all EREITs tested, 48% demonstrated price dependency at lag one. This means that 48% of the securities tested had some degree of price dependency with regard to their own price on the prior day; hence, the price of a security on day t is dependent on the price of that same security on day t

sub -1

. Additionally, 35% of the EREITs tested indicated a two-day price dependency, i.e., the price of a security on day t is dependent on the price of that same security on day t

sub -2

. Finally, at least one security demonstrated dependency for all but two of the time periods tested for each EREIT

Exhibit I

Exhibit 2

Short-term price dependency may be an indication that new information is not being made available to all investors at the same time or that many EREIT investors react rather slowly to the infusion of new information. Whatever the case, one might conclude that the autocorrelation test provides some support that a certain degree of inefficiency existed in the EREIT market during this time period.

Conclusion

The results of both the runs test and the autocorrelation test would suggest a degree of inefficiency in the EREIT market, at least for the time period examined. This can certainly be claimed in the short-term. In this context, the short-term would refer to the one and two day price dependencies that were derived from the autocorrelation test. The runs test provided evidence of general price dependency, and the autocorrelation test supports this conclusion based on the evidence of strong price dependencies with respect to lag one and lag two, which refers to one- and two-day price dependencies.

One possible explanation for this phenomenon is that investors may respond slowly to new market information or information is slowly and inefficiently spread throughout the marketplace allowing only a small portion of the investment community to benefit from newly arriving information.

Other plausible explanations for this phenomenon may be related to the characteristics of real estate assets and markets. For example, because of the predictable cash flows from leases, REIT pricing is more bond-like in nature and thus more serially correlated. In addition, the REIT market is very small and thinly traded, thus market makers may have an influence on prices. In either case, at least for the period examined here, there is a

demonstrated degree of inefficiency in the EREIT market.

Endnote

1. The spectacular growth experienced by REITs during the 1990s can be attributed to changes introduced with the 1986 Economic Recovery Tax Act, the difficulties faced by private real estate companies to obtain capital during the late 1980s and early 1990s, and changes in the structure of REITs. For a detailed explanation see Mullaney (1998).

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Geographic Names: United States; US

Descriptors: REITs; Studies; Portfolio management; Rates of return

Classification Codes: 8360 (CN=Real estate); 9130 (CN=Experimental/Theoretical); 9190 (CN=United States); 3400 (CN=Investment analysis & personal finance)
Print Media ID: 34769

30/9/19 (Item 19 from file: 15)
02092985 64828874

Submarkets matter! Applying market information to asset-specific decisions

Taylor, Michaell; Rubin, Geoffrey; Lynford, Lloyd
Real Estate Finance v17n3 pp: 7-26
Fall 2000
ISSN: 0748-318X Journal Code: RFN
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 20 Pages
Special Feature: Illustration Table Graph
Word Count: 7358

Abstract:

In this article, submarkets are defined and the property-level data that best supports the development of submarket indicators are best described. Submarket dynamics are examined along with three primary dimensions: performance level, growth rate, and volatility. This overview demonstrates that market fragmentation along one or more dimensions is fairly common. The overall importance of submarket location on property performance is estimated across 50 metropolitan-area markets. The technical issues involved in partitioning variance among factors in statistical **analysis** is discussed.

Text:

Commercial real estate analysts have traditionally relied on metropolitan-area or "market" statistics to anticipate the performance of properties located within their boundaries. Necessity drives the reliance on market data as much as choice, for more granular data is only now becoming widely available. Commercial real estate analysts must determine the usefulness of more discrete geographic information and incorporate it more effectively into their decision-making. This article considers the incremental **value** of submarket data in the **analysis** of multi-family and office real estate markets. As demonstrated here, metropolitan market statistics tend to paint unique localized real estate conditions with the same broad brush. The proliferation of submarket-level internet sources permits more precise **analysis**. We conclude that submarket conditions are substantially and measurably more important than market conditions in describing property and **portfolio** performance.

Fundamental supply and demand undercurrents might vary within metropolitan areas or "markets." The impact of these undercurrents on property performance and risk has not yet been quantified. A multidimensional exploration of intra-MSA dynamics and their power to disrupt the assumption of market unity is examined here. This paper ultimately considers whether submarket location is important to property performance, after accounting for larger market dynamics. In so doing, a distinction is drawn between "unified" and "fragmented" metro markets. Unified markets, with their

relatively weak submarket distinctions, imply comparatively homogenous real estate dynamics in all corners of the market. A single market-level indicator poorly describes local real estate conditions within "fragmented" markets. Submarket forces within fragmented markets create disparities in performance levels, growth, and volatility across the geographic market. Submarket information is more important in fragmented markets, but we will show that even relatively unified markets exhibit important submarket variances.

This article begins by defining submarkets and describing the property-level data that best supports the development of submarket indicators. Next, we examine submarket dynamics along three primary dimensions: performance level, growth rate, and volatility. This overview demonstrates that market fragmentation along one or more dimensions is fairly common. The overall importance of submarket location on property performance is estimated across 50 metropolitan-area markets. Results are remarkable: between 40% and 50% of a property's overall performance is explained by submarket factors, while only 10% is explained by metropolitan market factors.

Finally, we discuss the technical issues involved in partitioning variance among factors in statistical **analysis**. With this discussion as a backdrop, the robustness of estimates of submarket influence is rigorously tested. We find that the power of submarkets in determining property-level performance is consistent and robust to model specification, model estimation, and a priori assumptions.

DEFINING SUBMARKETS

Market areas (typically defined as Metropolitan Statistical Areas) can be partitioned into an arbitrary number of sub-regions. A partition that yields satisfactory submarket definitions should satisfy the following three criteria:

Properties within submarkets should be more "similar" than properties across submarkets, where similarity is measured by both physical stock characteristics and the rents that properties command. Submarket definitions should conform as well as possible to the patterns of locational preference expressed by end-users of the relevant space-type. Submarket definitions should account for vehicular and mass transportation patterns, natural barriers, the location of competitive projects, and the profiles of residents and workforce.

Over the past 20 years, Reis has refined a particular submarket convention for 50 U.S. multi-family and office markets. Reis's submarkets are defined in accordance with the above principles and compared to submarket definitions utilized by local brokerages and research firms. After developing the boundaries through this process, Reis coded its results in a Geographic Information System (GIS) that supported the spatial manipulation of multiple data sets and the thematic mapping of the results. By arraying locational, structural (age, size) and performance (particularly rent) data across the market area, one can identify geographical gradients or pockets, as suggested by property-level information. Exhibit 1 is a map of implied rent gradients in the San Antonio office market (shown by the dark dotted lines) along with an overlay of the Reis submarket boundaries (marked by colored areas). Similar gradients for property age were also generated. An analyst familiar with the marketplace processed this intelligence and, in conjunction with GIS "layers" of maps delineating political (state, city boundaries), geographic (rivers, mountain ranges), and engineering (development limits, roads) boundaries, established final submarket boundaries.

There are 638 competitive multi-family submarkets and 446 competitive office submarkets in the 50 Reis primary markets. The median multi-family market contains 11 submarkets, with a high of 37 in the Los Angeles market. The median office market contains eight submarkets, with a high of 21 submarkets in both Los Angeles and suburban Virginia. Submarket boundaries are occasionally enlarged in order to encompass new regions of real estate development, but boundaries are typically fixed in order to preserve time-series integrity.

Submarkets, as their names imply, are not priceclearing marketplaces; supply and demand spillover from other submarkets confounds the pricing dynamic. Decreased submarket vacancy, for example, might not stimulate rent growth because of space availability-or even the threat of space availability-in neighboring submarkets. In a completely frictionless marketplace, submarket distinctions are meaningless, for supply and demand can instantly shift in response to local shocks in real estate conditions. All markets have some degree of supply/demand stickiness, however. Supply is relatively static, particularly in the short term (inventory is not easily moved from one submarket to another). Advantages and disadvantages in inventory quality across regions of the market are slow to equilibrate. Even longer-term supply shifts-new construction-are imprecise and delivered at a substantial lag in response to real estate conditions. Intra-market demand is always more fluid than supply, but even so, tenants will not move en masse from one submarket to another in response to small changes in submarket conditions. The transaction costs of submarket supply and demand relocation ensure that submarkets, while not totally unique markets, will demonstrate some degree of independence from their neighbors. The magnitude of independence is an empirical issue that we explore below.

EXHIBIT 1

CREATING SUBMARKET TRENDS

After defining geographic submarket boundaries, attention turns to creating submarket-level real estate statistics. Creating rent statistics for either markets or submarkets is not trivial, because geographies do not charge rents, properties do. Reis has chosen to define rent and vacancy for any geographic region as the average rent and vacancy across properties located in that geographic region, weighted by property size (square feet for office, units for multi-family). This approach is data intensive-it requires updated rent and vacancy information on substantially all properties located within the geographic region. Less data-intensive definitions of market and submarket performance include same-store or derived rent indices, small-sample trend extrapolation, or surveys of market analysts.' The reliability of such approaches, particularly at the level of submarket resolution, is an open question.

Reis maintains a proprietary database of over 90,000 multi-family and office properties (in the top 50 metropolitan markets) that includes information on property age, size, location, leasing contact, and several performance measures discussed below. Reis's coverage of the total estimated competitive inventory exceeds 90% in 45 of the 50 primary office markets and 33 of the 50 primary apartment markets. Even in markets where Reis's coverage represents a smaller percentage of the total inventory, the absolute number of observations provides a robust basis for property-derived submarket and market trends.

Property contacts are periodically surveyed to provide updated information on asking rents, vacancy, concessions (including free rent periods) and, in the office sector, tenant improvement allowances, average length of lease term, commissions and expenses. Once this information is obtained, Reis attempts to quantify the typical discount off the asking rent necessary to

complete the transaction ("contract rent discount"). Reis has surveyed properties annually through 1998 and quarterly thereafter.2 Approximately 40% of the Reis inventory in each market and submarket is surveyed each quarter. Current rent, vacancy, concession, and expense estimates are then generated for the remaining 60% of the stock using standard panel-data econometric techniques. Two important classes of information are known about the stock not surveyed in any particular quarter: the fixed structural characteristics of these properties (age, size, floor plate, unit mix, and, most importantly, location) and their **historical** survey responses. Properties are typically contacted every two to three quarters, and less than 5% go a full year without a survey. The combination of current cross-sectional evidence provided by the 40% sample and longitudinal evidence provided by the properties, themselves, supports a very accurate estimate of current performance for properties not surveyed in the current quarter. The typical error in the property-level rent estimation is less than 13 cents annually per square foot for office properties and seven dollars monthly per unit for multi-family properties.3

EXHIBIT 2

The complete panel of property-level performance information (either surveyed or estimated) provides the raw information for quarterly submarket trends. Trend points are simple weighted-averages of performance for the properties located in that submarket. The 2000, first quarter, gross asking rent level of $18.50 per square foot for the Delray Beach office submarket in Palm Beach is the simple weighted average of asking rents for the 22 properties (1.1 million square feet) in that submarket. This approach places a heavy onus on property-level data collection-ten-year trends require ten years of reliable property-level survey data-but there are at least three attractive features of this approach. First, submarket and market trends are internally consistent, for the latter is defined as the weighted-average performance across all properties located in the market area. Stated differently, the average of all submarket rents and vacancies in a market, weighted by submarket inventory, equals the market rent and vacancy for that period. Second, Reis's quarterly surveying work permits quarterly updates of both market and submarket trends. Reis releases updated quarterly trend information within a month of the quarter close, providing a timely view of submarket inflection points.

THE IMPORTANCE OF SUBMARKET DATA RESOLUTION

This section measures the relevance of submarketlevel commercial real estate information. Submarket trends might differ from the larger market trend for a variety of reasons. We examine four different dimensions of market fracture in this section:

The difference between market and submarket revenue levels.4

The difference between market and submarket revenue growth rates.

The difference between market and submarket revenue growth volatilities.

The covariance between market and submarket revenue growth rates.

Each measure of market fracture is explained and measured, and each of 50 markets in both the apartment and office sectors is ranked according to the typical similarity between market and submarket. Markets show significant fracture in each of the four measures examined.

EXHIBIT 3

Rent Level Differences Across Submarkets

Rent levels should certainly differ across submarkets,5 for submarkets are created with the intent of isolating groups of properties with unique physical characteristics. Submarket location also directly affects rent levels-better-located submarkets should have higher rent levels, even if their underlying properties are physically average. In practice, the rent premium or discount a submarket commands relative to the market can be decomposed into locational and physical components. Consider the table in Exhibit 2 of submarket rent differences in the Seattle apartment sector as of March 31, 2000. A regression of property rent on a vector of physical characteristics and a dummy variable for submarket location allows us to identify the relative importance of location and characteristics in determining submarket rents.6

The West Seattle/Burien submarket, for example, has an average asking rent of $711, or $97 less than the market average of $808. Submarket location accounts for $69 of that typical $97 discount in West Seattle/Burien. In other words, a West Seattle/Burien location, regardless of property characteristics, will tend to decrease property rent by $69. West Seattle/Burien properties also tend to be older and smaller than average, accounting for the remaining $ 28 difference between the submarket and market average. Most of the difference between submarket and market rents in Seattle is directly attributable to property location, not a substantial difference in stock characteristics.

Exhibit 3 summarizes the level differences in submarket gross revenue (again, defined as the product of asking rent and the occupancy rate) as of December 31, 1999, within each of the 50 multi-family and office markets. Each market exhibits some degree of submarket dispersion around the market mean, with wider dispersion in markets such as New York and Boston than San Bernardino or New Orleans.

EXHIBIT 4A

In one sense, submarket differences in rent and gross revenue levels describe a dimension of fracture within a marketplace. Average market rent or revenue is a poor proxy for submarket (and property) rent or revenue in markets such as San Francisco and San Jose. That said, different rent and revenue levels across submarkets are easily controlled for if these differences are stable over time. Of more critical interest is whether rent and revenue growth rates systematically differ across submarkets. Submarket revenue growth rates will behave differently than the overall rate to the extent that transaction costs or supply/demand stickiness exists within the marketplace. The following section considers differences in rent growth rates across submarkets.

Divergence Between Market and Submarket Revenue Growth Rates

What is lost by applying market rather submarket growth rates to a particular property? The market growth rate is, itself, an average of the underlying submarkets, some of which will grow faster and some slower in any particular year. The first two columns of Exhibit 4a consider the typical annual difference between submarket and market revenue growth in the multi-family sector and Exhibit 4b does the same for the office sector. The Portland apartment market, for example, grew at an average rate of 3.5 % per annum over the 1990s. Portland's submarkets had an identical average growth rate for the period, but the typical submarket/market difference in any year was 1.4 percentage points. Using the Portland apartment market growth rate as a proxy for the correct submarket growth rates implies a typical annual error of 140 basis points. Submarket/market growth rate differences were greater in some of Portland's seven submarkets and smaller in others, but the average absolute error for the decade was 140 basis points-you can expect to be "wrong" by this amount if you use Portland

market revenue growth instead of the appropriate submarket growth rate.

EXHIBIT 4B

Typical annual apartment market revenue growth errors range from the Portland low of 140 basis points to a high of 400 basis points in New York. The typical error of using market rather than submarket revenue growth in the office sector is even greater, ranging from 230 basis points in Memphis to 870 basis points in Cleveland. The shortcut of using market rather than submarket growth rates carries some cost of imprecision. Exhibit 4a and 4b quantify this cost. Analysts must decide if the imprecision of general market growth rates is acceptable for any particular **analysis**.
We will use column two of Exhibit 4a and 4b as our second measure of market fracture.
The above **analysis** confirms that submarket growth rates can differ substantially from the market in any particular year. The impact of this annual error might be blunted if submarket growth rates tend to converge to the market rate over longer periods. Highgrowth submarkets in one year might be low-growth submarkets the next; if annual submarket/market growth rate differences are **random**, growth differences will even out over time and market growth can be safely used for longer-term **analysis**. Columns three through five of Exhibit 4a and 4b show annualized revenue growth rates for the fastest- and slowest-growing submarket in each market over the past decade, as well as the difference between the two. This data confirms that submarkets can outperform or underperform the market for long periods of time. Gross revenue in the top Houston office submarket, for example, as indicated in Exhibit 4b, grew at an annualized rate of 9.6% over the 1990s, while the worst submarket grew only 2.4% per year. Clearly, the overall Houston market growth rate of 6.2% for the period is a poor proxy for the long-term performance of these two submarkets. The use of market growth rates to explain submarket growth patterns entails a great deal of imprecision, regardless of the holding period.

Differences in Submarket and Market Volatility

Submarket/market differences in revenue growth volatility comprise a third measure of market fracture. Market revenue growth trends are "smoother" than underlying submarket growth trends, for the former is an aggregation of the latter. Important revenue growth spikes and dips at the submarket level can be overlooked when examining just the market growth rate. This section measures the magnitude of volatility at both the market and submarket level and considers the extent to which the use of market growth rates conceals the impact of meaningful submarket-level rent growth volatility.

EXHIBIT 5

First, consider the year-over-year volatility of submarket and market revenue growth, where volatility is measured as the average absolute change in the year-overyear growth rate for the period 1989 to 1999. Exhibit 5 shows the calculation of average revenue growth volatility for the San Antonio West office submarket and the San Antonio market as a whole. Typical year-over-year volatility in San Antonio West, 5.2%, exceeds volatility in the market as a whole by 160 basis points. Property owners in the San Antonio West submarket face substantially more volatility or risk than that suggested by the overall market measure of volatility. Market revenue growth trends suppress vital submarket information in those cases where submarket volatility greatly exceeds market volatility.

Exhibit 6 shows volatility at the metro and submarket levels and helps identify those markets where submarket volatility demands specific

treatment. Looking first at column one, we see that Kansas City has a market volatility level of about 1.5%, meaning that revenue growth rates typically vary only about 150 basis points per annum in the Kansas City market. On the opposite end of the spectrum, revenue growth in the Boston office market tends to vary almost 600 basis points.

The second column shows average volatility across all submarkets in the market. Higher levels of submarket volatility identify those markets where the overall revenue growth trend suppressed important submarket-level volatility. The New Orleans office market, for example, has below-average metro-level volatility but above-average submarket volatility **Portfolio** managers thinking that a New Orleans office asset will benefit from relatively stable revenue growth may be deceived by market data, depending on the submarket location of their property.

Exhibits 7 and 8 illustrate specific examples of market and submarket revenue growth volatility. The first figure shows **historical** revenue growth for the nine Boston office submarkets.

Revenue growth volatility (the size and frequency of "peaks" and "valleys") is similar in most of the Boston submarkets. Certain submarkets vary from the general volatility pattern at particular points in time, but the significant metro volatility experienced over the past 10 years has been roughly mimicked at the submarket level. The market-wide measure of revenue growth volatility is a relatively good indicator of revenue volatility for the various Boston submarkets.7 Although there is a wide dispersion in revenue levels (Exhibit 3) and growth rates (Exhibit 4), Boston's submarkets share similar **historical** submarket revenue growth volatility patterns.

EXHIBIT 6

The Austin office market tells a different story. Market volatility in Austin is rather mild (Exhibit 9), but submarket revenue growth demonstrates high volatility. As seen in Exhibit 8, almost every Austin submarket has experienced wider revenue growth swings than the market as a whole. Austin's market volatility suggests market stability, but Austin properties are subject to substantially more volatile conditions at the submarket level. In markets such as Austin, reliance on metro-level real estate data can prove deceiving. We previously demonstrated that market-level measures of "return" or growth can suppress important submarket-level variations; this **analysis** of revenue growth volatility suggests that market-level measures of "risk" suffer from the same shortcomings.

Correlation Between Submarket and Market Revenue Growth

The volatility statistics presented above consider the size and frequency of revenue growth swings at the market and submarket levels. We might also ask if the timing of market and submarket peaks and valleys coincide, regardless of their size and frequency. The error of using market-level trends is firther compounded if market upturns and downturns do not correspond to similar movements at the submarket level. The correlation between market and submarket revenue growth rates comprises our fourth and final measure of market fragmentation.

Exhibits 9 and 10 measure correlation between market and submarket revenue growth rates for the 50 office and multi-family markets. Submarket correlations are defined as the average of the correlations of each submarket to the metro average during the 1990s. There is little accord between submarkets and the overall market in those markets listed at the top of the table. Market revenue growth is not an effective proxy for

submarket growth in these markets. Submarket and market movements are more unified in those markets listed at the bottom of the table.

San Jose's **historical** office submarket revenue growth patterns, for example, are highly correlated with the overall market trend. Shown in Exhibit 11, the timing of the market growth pattern provides good insight into the timing of the underlying submarket growth rate patterns. While the market trend is not a perfect substitute for submarket data revenue levels, growth rates, and volatilities in the five submarkets are still distinct -a powerful **historical** correlation in growth rates exists.
Pittsburgh gives the opposing view (Exhibit 12). The five Pittsburgh submarkets demonstrate five distinct growth patterns. Clearly, the timing of Pittsburgh market revenue growth rate changes is not a good indicator of submarket revenue movements. Using market-level revenue growth swings in markets such as Pittsburgh can yield inaccurate measures of revenue growth at the more localized submarket level.

EXHIBIT 7

EXHIBIT 8

Overall Market Fragmentation

Exhibit 13 combines the four measures of market/submarket cohesionrevenue levels, revenue growth rates, revenue growth volatilities, and revenue growth correlations -into a single measure, allowing a ranking of markets by their overall unity or fragmentation. Each market within the two sectors was ranked in the four fragmentation measures, where the most fragmented market in each category is given a rank of "1" and the least fragmented a rank of "50." The "Cumulative Fragmentation Rank" is defined as the average market rank across the four fragmentation measures. A Cumulative Fragmentation Rank of 5, for example, suggests that the market is, on average, the fifth most fragmented market across the four measures of fragmentation. Using this crude measure, we can conclude that market revenue trends in suburban Virginia and Houston office markets and Sacramento and Charlotte apartment markets conceal a great deal of submarket flavor. Submarket trends follow the market more closely in office markets such as Memphis and Pittsburgh and apartment markets such as Memphis and San Bernardino. Exhibit 13 does not quantify the magnitude of market fragmentation, however-even those markets at the bottom of the table display some meaningful fragmentation in at least one measure of submarket cohesion. In general, market data is typically not a good substitute for submarket data, even though the magnitude of this error varies across markets. Even in relatively unified markets, it can be shown that submarket information remains beneficial.

EXHIBIT 9

THE IMPACT OF MARKETS AND SUBMARKETS ON PROPERTY PERFORMANCE

We have thus far only considered the divergence between market and submarket data. A second research objective considers the impact of market and submarket data on property performance. If property performance is independent of both market and submarket trends, the conflict between market and submarket data is rather trivial. All markets show some degree of market/submarket fragmentation. In cases where the two diverge, which has a more potent impact on property performance?
To study this issue, we regressed property revenue levels on contemporaneous and the first three lags of market revenue level, contemporaneous and the first three lags of submarket revenue, the first two lags of property level revenue, and fixed property characteristics8 for the multifamily and office properties in our database.

EXHIBIT 10

Exhibit 14 shows the relative weight of these factors on determining property revenue levels in the office sector. This **analysis** shows that submarket trends are the most important determinant of property performance -nearly 40% of all property revenue variance is explained by submarket factors. Metro level trends explain only 11% of property revenue variance.9 Property structural characteristics explain an additional 35% and 15% of variance is left unexplained by the model (such factors may include temporary shocks, effects of remodeling, and the loss of large tenants). The bottom line is that submarket factors are far more important than metro-level trends in assessing propertylevel performance. Similar models were estimated on average rent levels (as opposed to revenue levels) with similar substantive results. Exhibit 15 shows that the relative importance of submarket data is even stronger in the apartment sector. These results attest to the incremental **value** of submarket data in analyzing property performance. Reliance on just market-level data dramatically erodes the analyst's ability to explain property-level performance.

ASSESSING SUBMARKET IMPORTANCE

Exhibit 16 presents the first look at the model results. Model A of Exhibit 16 presents the first iteration of models. Estimates are calculated using ordinary least squares methods. This model shows the results of property rent levels regressed on its own first two lags, the size and number of floors of the property, and the metro and submarket average rent levels. Durbin M statistics are presented in the last row and show that Model A has some problems associated with correlated errors. This is not unexpected given that no lags for the submarket and market forces are incorporated into the model (except indirectly through the lags of the dependent variable). Nevertheless, with over 200K observations, even autocorrelation is not expected to have a noticeable effect on error estimates on the regressors. This first, admittedly rough, take on the model shows that submarket factors greatly outweigh market factors. The regressor estimate for market factors (0.086) is only 30% of the estimate for submarket factors (0.281). The scale of the two independent variables makes direct comparison of unstandardized coefficients possible. Total variance explained in model A is 0.79. Durbin M statistics for Model A indicate the presence of autocorrelated error terms, even given the inclusion of the lagged dependent variable. Of course, autocorrelation is not typically worrisome with a sample of this magnitude, but the presence of lagged dependent variable forces increased attention on correlated errors.

Model B includes lags of the market trends as the first attempt to more fully model the serial pro-cess. Past measurements of submarket trends are not included in Model B. This model, as expected, continues to exhibit autocorrelation. Lags of market trend indictors achieve significance and substantially reduce the autocorrelation problem (Model B Durbin M declines to 21.3 from the 142 estimated in Model A). It is crucial to notice that inclusion of the metro level trends does not reduce the efficacy of the contemporaneous submarket indicator.

EXHIBIT 11

EXHIBIT 12

Model C shows the fully specified model. It contains contemporaneous and lagged values for market and submarket factors. Again, the estimates on the submarket and market factors can be directly compared. Contemporaneous market factors ($b = 0.186$, $p < 0.01$) exhibit only 30% of the power of

submarket factors (b = 0.669, $p < 0.01$) to explain property rent levels. Standardized coefficients (not shown in Exhibit 16 but summarized in Exhibit 18) reflect these relative weights as well, with contemporaneous market indicators achieving a Beta (standardized regressor) of 0.1496 and contemporaneous submarket factors achieving a Beta of 0.596. Remarkably, the regressors on the first and second lags of market trends are also about 30% of comparable submarket estimates. Durbin M statistics for this fully specified model indicate that autocorrelation has been effectively expunged. Total explained variance stands at 85%.10 Total variance explained by submarket factors, as presented in Exhibit 14, are computed by the authors using the summation of absolute values of submarket related standardized coefficients over the sum of all standardized coefficients plus unexplained variance.

In large panels in which the number of panels greatly exceeds the number of time periods, error estimates can be shown to be underestimated. In cases in where the panel is twice as large as the number of time periods, Parks corrections to error terms are also insufficient. Instead, the results from the models shown in Exhibit 16 have also been estimated using panel corrected standard errors (PCSE, see Beck and Katz [1995] Wawro [2000]. The error estimates using PCSE corrections (not shown here, but available from the author upon request) are slightly larger than those shown in Exhibit 16 but still produce student's t statistics for the variables of interest of greater than 10.11

EXHIBIT 13

Cross-sectional pooled time-series **analysis** such as this is also vulnerable to panel heterogeneity. To the extent that variance in some panels is significantly larger than in other panels, the heterogeneous panel effectively assumes a weighting in OLS that is greater than its intended weighting. It is easy to imagine that volatile markets and properties would tend to dominate OLS results based on real estate rents. This may create biased estimators if not controlled. To assess the effect of heterskedasticity on these results, the sample was split into three groups based on levels of variance in the dependent variable. Model C of Exhibit 16 was then estimated on each sample. The results (not shown here but available from the author upon request) do not differ significantly from the full sample estimates. There simply appears to be no change in the **value** of coefficients when the model is iteratively applied to properties exhibiting various levels of volatility.

Reassessing Submarkets Using Growth Specification

Exhibit 17 re-assesses the robustness of the estimated coefficients contained in Exhibit 16. This Table repeats the basic estimation strategy of Exhibit 16 but defines the dependent and independent variables in terms of percent change instead of levels. Models focusing on growth levels are much less subject to multicollinearity than are levels models due to an inherently lower correlation.

Model A of Exhibit 17 shows the naive model in which property level annual growth rates are regressed against their lags, property level characteristics, and contemporaneous market and sub-market growth rates. We again see in Model A that submarket factors dominate market factors with the regression coefficient for submarket factors (b = 0.736, $p < 0.01$, Beta = 0.29) being more than twice the size of comparable metro estimates (b = 0.355, $p < 0.01$, Beta = 0.126). These results provide preliminary confirmation of the relative importance of market and submarket factors to influence property level rents shown in Exhibit 16.

Model B is the fully specified model and can be compared to Model C of

Exhibit 16. We again see that contemporaneous market forces exert only approximately 30% of the power that submarket forces exert in the determination of property rent growth throughout the included lag structure. Shifting metrics clearly does not effect the substantive conclusion that submarket performance is of substantially greater import than metro market performance in determining property level performance.

Submarket ImportanceAnother (Grangerian) View

Estimation strategies in Exhibits 16 and 17 use the overwhelming power provided by the dataset to partition the shared variance of market and submarket factors to each individual factor.

EXHIBIT 14
EXHIBIT 15

EXHIBIT 16

EXHIBIT 17

An alternative view is to a priori partition shared variance to metro factors and then assess the efficacy of the unique submarket variance. Exhibit 18 presents model results based on this strategy. Of course this strategy is expected to grossly overestimate MSA factors' importance and underestimate the importance of submarket factors—hence stacking the deck against finding submarket effects. Here the dependent variable is the error term from property level rents regressed on its first two lags, property structural characteristics, and market level factors. To the extent that submarket factors are correlated with market level factors, the common variance will be subsumed through the market coefficient estimates (more formally –omitted variable model misspecification will result in positively biased coefficient estimates on the metro trends variable owing to positive correlation with the omitted variable).12 Model A of Exhibit 18 presents results on a levels specification. The effect of the assumption that all shared variance "belongs" to market factors is reflected in the generally lower estimates achieved by the submarket factors compared to the more appropriately specified models in Exhibit 16, Model C. Model B is similarly defined using a growth model. Again all elements of the vector of submarket factors are significant but with estimate magnitudes eroded by the bias towards finding market and not submarket factors.

Each model shows that even with the strong assumption that all common variance "belongs" to market forces, submarkets still matter. That is, even with the deck heavily stacked against finding any significant submarket forces, the effect of submarkets is striking. In each case all included lags are statistically significant.

Effects of Multicollinearity on Model Results

As one might expect, the independent variables of these models of rent levels and growth are seriously correlated both with their own lags and with contemporaneous indicators of property, metro, and submarket trends. Normally, multicollinearity presents researchers with stark choices and nearly insurmountable obstacles to partitioning variance among the correlated indicators. The three common suggestions to dealing with multicollinearity are to 1) drop one of the correlated indicators (see Granger discussion above); 2) combine the indicators into a measurable index; 3) obtain more data. Given that the effort here is to explain the relative power of the correlated indicators, the first two suggestions are clearly not appropriate. The last suggestion is largely already accomplished, as each of the above equations are estimated on approximately 200,000 cases.

In assessing the effect of multicollinearity in the interpretation of these models, it is useful to remember the exact effects of multicollinearity on ordinary least squares estimates. Given multi-collinearity, regressor estimates remain unbiased but inefficient (Hanushek and Jackson, [1977]; Kelejian and Oates, [1989]). "The OLS estimator in the presence of multicollinearity remains unbiased and in fact is still BLUE.... The major undesirable consequence of multicollinearity is that the variances of the OLS estimates of the parameters of the collinear variables are quite large" (Kennedy, [1992]). The point, of course, is intuitive. As collinearity increases, the amount of unique information contributed by each covariate decreases. Information becomes scarce. It is clear from Exhibit 16 that inflated error estimates on model parameters and scarcity of information are hardly an issue. This also clearly demonstrates the utility of suggestion number three. In model C, the coefficient estimate on contemporaneous submarket trends is 133 times its error estimate. Although error estimates may be slightly biased upwards in the errors of the parameter estimates, the amount of data available has overwhelmed any concerns of inflated errors.

EXHIBIT 18

An indication of multicollinearity problems in an equation is coefficient estimates which are unstable. That is, coefficient estimates vary depending of the sample of data the estimate is based on. Researchers using smaller datasets often see parameter estimates fluctuate wildly depending upon sample draws from the dataset. In fact, an effective test for multicollinearity is to split the sample **randomly** into two pieces and repeat the estimation strategy, noticing any instabilities in the estimates.

To illustrate the power of large datasets to overwhelm the instabilities associated with multicollinearity, a series of simulations have been produced. Using the size of the dataset as leverage, an iterative **random** sample is drawn of an arbitrary sampling size. For simplicity, the following model is estimated:

rentGrowth = alpha + beta

sub 0

MarketGrowth + beta

sub 1

SubmarketGrowth + Sigma betagamma + epsilon

where, gamma represents the vector of idiosyncratic factors.
This equation is Model A, Exhibit 17. Our interest lies in the distribution confidence **interval** associated with Po and Pi. The simulations begin by **randomly** pulling 500 observations from the dataset and estimating Po and Pi in the equation above. This is repeated another 499 times (with replacement), each iteration providing parameter estimations at the "500 observation" level. The entire procedure is then repeated another 500 times, but with 1,000 **randomly** selected observations used to estimate fo and P3i and forming the "1,000 observation" level parameter population. Samples ranging in size from 5,000 through 200,000 are subjected to the same procedure. Exhibits 19 and 20 show the results of these simulations.

EXHIBIT 19

Exhibit 19 shows the results for metro level indicators. The left panel of

Exhibit 19 contains descriptor bars for the population of coefficient estimates from the 500 iterations for each observation level. That is, the first bar indicates that the mean coefficient estimate on metro trends given 500 **random** draws, each with 500 observations, is approximately 0.22 (inferred by the midpoint of the shaded bar). The population of coefficient estimates is further described by the magnitude of the shaded bar which indicates two standard deviations of the population of coefficients about the mean coefficient (0.22). The thinner line of the first bar indicates the range of coefficients. The power of the larger sample sizes to converge on a true estimate is strikingly illustrated by this graph. As the sample size increases, as expected, the distribution of coefficient estimates sinks rapidly with a consistent mean estimate.

The right panel indicates the 95% confidence **interval** for the mean coefficient (using the mean error estimate from the population of error estimates) for each observational point. As can be seen from this diagram, small sample sizes and multicollinearity would preclude statements of significance in the first and possibly second iterations (with n = 500 and n = 1000, respectively) because the lower bounds encompass zero. Although mean estimates bounce around somewhat within the confines of their standard errors on the leftward most edge of the simulations (presumably due to multicollinearity), the middle and rightward edges again show strong significance and stability.

The same can be said of the submarket estimates shown in Exhibit 20. Again we see that small samples produce high errors and widely distributed coefficient estimates across the draws, as expected with any model but particularly where a multicollinearity issue is involved. However, even moderate increases in sample size quickly bring distributions and errors to more tolerable levels.

EXHIBIT 20
Effects of Market Fragmentation on Model Results

The foregoing **analysis** pools data across all metros. Remember, however, that certain metros evince more fragmentation (or unification) than others. The distinction between submarket and market effects is stronger in fragmented markets. Exhibit 21 shows the results of growth model (presented in Exhibit 17) for the 15 most fragmented and 15 most unified markets separately. Model A in Exhibit 21 indicates estimates for the least fragmented, while Model B presents comparable estimates for the most fragmented, In theory, submarket factors should be most important in those markets in which fragmentation is most pronounced. Therefore the relevant comparison here is between coefficients on the submarket factors between Model A and Model B. The submarket contemporaneous coefficient in Model B (0.837) is substantially higher than the similar coefficient for more unified markets (0.717). Indeed, the increased power of submarket factors to determine property-level performance is repeated for all included lags. A glance at the magnitude of the coefficients indicates that the difference is significant. Just as important, Model A continues to show that even in the most unified markets, submarket factors continue to dominate MSA level factors.

SUMMARY

Analysts seeking to explain or predict the performance of single properties or groups of properties have long relied upon market-level data. Evidence presented here suggests that market-level data is too coarse a measure of either submarket-or property-level performance. We argue that submarket data is the better measure of performance for both geographic regions and for specific properties. We demonstrate the divergence of market and submarket revenue indicators along a variety of dimensions. Simply put,

market-level data is a poor substitute or proxy for more granular submarket-level data. We show that these independent submarket trends are a superior indicator of property performance, and then show that the power of submarkets to determine property level performance is robust to samples, modeling techniques, and a priori modeling assumptions.

In sum, submarkets are unique from the market and are closer to the property. We do not suggest the abandonment of market data, but the omission of submarket data entails certain loss of precision. Clearly, strategies that incorporate information from both metro and submarket **analysis** are indicated.

EXHIBIT 21

ENDNOTES

1Brokerage firms typically use market rent indices, which can range in complexity from econometrically-balanced baseline samples to the simple updating of a small group of properties.

2Reis started surveying properties in some markets as early as 1980, but published series typically start in 1989.

3R.emember, these are zero-mean property-level estimation errors. When aggregated to submarket and market levels, these errors are even further minimized.

4Revenue is defined as the product of asking rent and occupancy rate.

5Rent levels in the apartment sector are defined as the weighted average rents across studio through 4-bedroom apartment units.

6Property = alpha+Sigma beta

sub 0

gamma + Sigma beta

sub 1

phi + e where gamma equals size, floors, and age of property and phi collection of dichotomous submarket dummy variables.
7Boston is also a good example of unified markets in terms of correlated growth patterns as described below.

8Structural characteristics include property age, size or total units, unit mix (for multi-family properties), age, number of floors, and four locational variables.

9A variety of analytical strategies have been used to estimate the relative weights of these factors. These include various growth and Granger models (not shown here). Even attributing all common variance to metro factors, submarkets remain very powerful indicators of individual level performance. In each case the relative weight of the submarket and metro factors were remarkably robust. For a more complete (and far more technical) discussion of the methodologies used please see the research note, "Disentangling Submarket from Metro Trends in Explaining Property Variance," available upon request from the authors.

10Better understood iterative Cochrane-Orcutt models (not shown here) substantively confirm results for Model C.

11Application of aggregate variables to explain discrete phenomenon can lead to an underreporting of error estimates on the regressors to the extent that there is a systematic and unmodeled intervening factor in the relationship between the micro unit and the aggregate regressor's magnitude. (See Moulton, [1990] and Klock [1981].) In the model under consideration here, no systematic process can be identified. The magnitude of the t statistics almost certainly would overwhelm any systematic process were it to be identified. Moreover, simulation results which follow add convincing evidence that the regressor error estimates remain robust.

12The magnitude of the bias is of course a function of the correlation matrix of omitted variable, dependent variable, and included variables.

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Geographic Names: United States; US

Descriptors: Commercial real estate; Metropolitan areas; Supply & demand; Revenue; Studies
Classification Codes: 9190 (CN=United States); 9130 (CN=Experimental/Theoretical); 8360 (CN=Real estate)

Print Media ID: 13978

30/9/20 (Item 20 from file: 15)
02091831 64957631

Forecasting with Excel

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Journal of Business Forecasting Methods & Systems v19n3 pp: 22-27
Fall 2000
ISSN: 0278-6087 Journal Code: JBT
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 6 Pages
Special Feature: Photograph Table
Word Count: 2634

Abstract:

Effective forecasting is unimaginable today without the use of a computer. Forecasting software significantly reduces the time required for preparing forecasts with different models. Microsoft Excel is one of the general-purpose software programs that can be used in forecasting. Excel as a spreadsheet tool is very popular today in business. Many businesses keep their data on Excel spreadsheets for business analysis and forecasting. Furthermore, it is widely used in academia.

Text:

Effective forecasting is unimaginable today without the use of a computer. Forecasting software significantly reduces the time required for preparing forecasts with different models. Microsoft Excel is one of the general-purpose software programs that can be used in forecasting. The main Excel features that are very useful in forecasting include:

* Several imbedded forecasting methods, like moving average, exponential smoothing, and regression.

* Ability to program virtually every forecasting method using spreadsheet formulas.

* Capability of drawing all kinds of charts and graphs.

* Capability to store, retrieve, slice and dice data - important part of forecasting. Furthermore, data can be easily exported to other programs and databases.

Excel as a spreadsheet tool is very popular today in business. Many businesses keep their data on Excel spreadsheets for business **analysis** and forecasting. Furthermore, it is widely used in academia. It is used in various courses in **finance**, operations research, accounting and statistics for problem solving.

FORECASTING METHODS IN EXCEL

Excel includes several forecasting methods that appear in the **Analysis** Tools dialog box. It can be opened by the Data **Analysis** command on the Tools menu. If this command is not

present, the Add-Ins command under the Tools menu should be used. In the Add-Ins dialog box, click a small check box in front of the **Analysis** ToolPak option, and then click the OK button. The Data **Analysis** tools will be installed in Excel.

After the Data **Analysis** command is clicked, the Data **Analysis** dialog box will appear on the screen. In this box, one can find several tools that are directly used in forecasting: Exponential Smoothing, Moving Average, Correlation and Regression. If the Add-Ins dialog box does not contain the **Analysis** ToolPak option, or there is no Add-Ins option in the Tools menu, then these options need to be installed from the original Excel installation CD or diskettes.

MOVING AVERAGE

To illustrate various forecasting methods in Excel, we will use a "real-life" sales data (in units) given in Table 1, cells D1:D19. Because of confidentiality the name of the company is not identified. This **historical** data will be employed to forecast the number of units in July 2000. We start our discussion of the forecasting methods in Excel with moving average-one of the most common tools used in time series forecasting. It is also one of the easiest methods to use and understand. Moving average is an averaging technique where several most recent values of **historical** data are averaged to produce the forecast for the next period. The term "moving average" represents the fact that as each new actual data point becomes available, a revised moving average is computed for the next data period requiring forecasting.

To develop a moving average forecast in Excel, the previously described Data in Excel, the previously described Data **Analysis** command on the Tools menu needs to be applied. In the Data **Analysis** box locate the Moving Average option, and click the OK button to open the Moving Average dialog box. In this dialog box, identify the Input Range (in our case, D1:D19). If the header is included into the range, click the Labels in First Row box. The **Interval** box represents the number of periods in the moving average. The default number is 3, which is applied to develop the forecast. This number indicates that the forecast for the next period is equal to the average of the three previous actual data values. In the Output Range box, enter or click on a cell that will serve as the starting point of the output. Always start the output range in period 2 (cell E3, in case of our forecast). The output is usually located in the column next to the one with the original **historical** data. In our data, it will be Table 1, column E. By using the same dialog box and different number of periods, several moving average forecasts can be developed on the same worksheet. (See moving average forecasts in Table 1 with the number of periods equal to 4, 5, 6, and 7 in columns F, G, H, and I, respectively).

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TABLE 1

In order to select a better forecast among the described moving average alternatives, the forecast accuracy measure of mean absolute percentage error (MAPE) is used. MAPE measures the average absolute error of a forecast expressed in percent. The lower the **value** of MAPE, the better the forecast. To calculate MAPE of forecasts given in column E, the following Excel formula in cell E21 is used:

E21: = AVERAGE(ABS($D5:$D19$E5:$E19)/$D5:$D19)*100.

This formula contains two Excel functions: AVERAGE (the average

value of a range) and ABS (the absolute **value** of a range) used in MAPE calculations. In order to apply the formula, CTRL-SHIFTEnter keys need to be pressed simultaneously. MAPE indicates that the forecasted **value** of 762 for the three-period moving average has an average absolute error of 3.2%.

Using the similar formulas, MAPE was calculated for all moving averages. The calculation results showed that the four-period moving average is the best among the moving average, and, as such, the **value** of 752 should be used as a forecast for July of 2000.

EXPONENTIAL SMOOTHING

Another forecasting method that can be easily used in Excel is exponential smoothing. It is one of the most used of all forecasting methods in time series forecasting. In exponential smoothing, only three pieces of data are needed to forecast the future: the most recent forecast, the actual data that occurred for that forecasted period, and a smoothing constant alpha (alpha) or opposite to it, a characteristic called the damping factor (1-alpha).

To forecast using exponential smoothing, click on the Data **Analysis** command on the Tools menu. In the Data **Analysis** dialog box move cursor to the Exponential Smoothing option, and click the OK button to open the Exponential Smoothing dialog box. In this dialog box, identify the Input Range (in our case, it is D1:D20). In the Damping Factor box, input the **value** of the damping factor. Let us use, for example, a damping factor of 0.1, which is opposite to the smoothing constant alpha of 0.9. Click on the Labels box because the data header (D1) is included in the range. In the Output Range box, enter cell E2:E20, and then click the OK button. The forecast for periods 2 through 20 will appear in the worksheet (Table 2, column E). The forecast for July 2000 is 743. By using the formula of MAPE as described earlier, we can compute the average absolute error of the forecasts which comes to 4.2% (Table 2).

In the described forecast, the **value** of damping factor (or smoothing constant) was selected **randomly**, and it is unclear if this is the best forecast using exponential smoothing. A special Excel tool called Solver allows identifying the best exponential smoothing based upon one of the selected accuracy measures. In our case, we will use Solver to identify the smoothing constant **value** that would produce a forecast with the lowest MAPE **value**. The following are the steps on how to use Solver (see Table 3):

1. Change the header in cell El to Best Forecast. Put a new header Best Alpha in cell Fl. Put any **value** of smoothing constant in cell G1. We are using alpha=0.9, or the damping factor 1-alpha = 0.1.

2. Change the formula in cell E4 from =0.1*D3+0.9*E3 to =G1*D3+(1G1)*E3. Copy the new formula into cells E5:E20.

3. In cell E21 input the following MADE formula:

=AVERAGE(ABS($D3:$D19$E3:$E19)/$D3:$D19)*100
Press CTRL-SHFT-Enter keys simultaneously to apply the formula.

4. Click on Solver in the Tools menu. This will open the Solver Parameters dialog box. In the Set Target Cell box input E21 or simply click on this cell. Click on the Min radio button. In the By Changing Cell box, input G1. To add necessary constraints to the Subject to the Constraints box, click the Add button. In the Add Constraint dialog box, input G1 in the

Cell Reference box, and I in the Constraint box. Then, click the Add button again. Input G1 in the Cell Reference box, click the button on the right from the box to change the sign to > =, and then input 0 in the Constraint box. Click the OK button in the Add Constraint dialog box, and then the Solve button in the Solver Parameters dialog box.

TABLE 2

5. When the Solver Results dialog box appears, click there the OK button. The optimal **value** of alpha will be in cell G1. In our case, this is 0.604. Based on the lowest received MADE of 3.8%, the best forecast using exponential smoothing for July 2000 is 744.

Excel computes only simple exponential smoothing with one smoothing constant. To perform double exponential smoothing, exponential smoothing with trend, or exponential smoothing with trend and seasonality (Holt's and Winter's models, respectively), additional spreadsheet columns with calculations and formulas are required. Here again Solver can be applied to identify the best smoothing constants.

LINEAR REGRESSION

Excel can also develop forecasts with linear regression, using one or more independent variables (explanatory variables, drivers or predictors). One of the benefits of regression forecasting is its ability to make predictions for several periods ahead (months, quarters). Using our data, we will apply linear regression to forecast the number of units from August through December of 2000. Here we will use only one independent variable, time, and predicted variable, number of units.

TABLE 3

Linear regression can be started by identifying how close the linear relationship is between the two variables, the time period and the number of units. For that, a correlation coefficient needs to be estimated. The **value** of correlation coefficient varies from -1 to +1. If the correlation coefficient is close to either +1 or -1, the relationship between the two variables may be described as statistically linear. If the correlation coefficient is close to zero or relatively small (e.g., 0.1-0.3), the assumption of a linear relationship is not valid and linear regression should not be used.
The correlation coefficient can be identified by clicking on the Data **Analysis** option in the Tools menu. In the Data **Analysis** dialog box, move the cursor to the Correlation option, and click the OK button to open the Correlation dialog box. In this dialog box, identify the Input Range (in our case, it is C1:D19). Click on the Labels in First Row box because the data header (D1) is included in the range. In the Output Range box, enter a cell where the output should appear. We may like to put output in cell F4. Then click the OK button. The correlation coefficient is equal to 0.839. This indicates that there exists a strong linear relationship between sales and independent variables and enables us to develop a meaningful regression forecast.

In order to see graphically how linear regression fits the **historical** data, a plot of **historical** data needs to be developed. This can be done by clicking the Excel's Chart Wizard button or by using the Chart option from the Insert menu. Select the Line chart and then follow the Chart Wizard's steps to develop the chart. The developed chart shows a definite pattern of growth (Table 4). The development of a regression line shown in Table 4 can be started by clicking the chart first and then selecting the Add Trendline command from the Chart menu. In the Add Trendline dialog box, select Linear for the

Trend/Regression type, then click on the Options tab. Click the boxes with Display equation on chart and Display R-squared **value** on chart. Then, click the OK button. The linear trendline and its equation will appear on the chart (see Table 4). The R

sup 2

valuegt; of 0.7043 shows that more than 70% of the variations of the predicted variable can be explained by variations of the time period.

To develop a linear regression forecast, click on the Data **Analysis**gt; command on the Tools menu. In the Data **Analysis**gt; box, locate the Regression option, and click the OK button to open the Regression dialog box. In the Input Y Range box, put the range of the dependent variable (in our case, D1:D19). In the Input X Range box, put the range of the independent variable (C1:C19). Click on the Labels box to incorporate the variables' names into the ranges and output. Click on the New Worksheet Ply button and put Al in the box associated with this button. Finally, click on the OK button. The regression equation on the output (Table 5) is defined by the intercept in cell BI 7 and the coefficient for the independent variable (period) in cell B18: Y = 639.32 + 6.6914*X.

TABLE 4

TABLE 5
TABLE 6

The output as given in Table 5 can be used to analyze the statistical significance ("statistical quality") of the regression equation. The most important parameters to consider are: the coefficient of determination R

sup 2

, the coefficient of regression, intercept, and F-statistic (Significance F).

In a regression with one independent variable, the coefficient of determination R

sup 2

is the square of the correlation coefficient (0.839). As mentioned previously, R

sup 2

should be relatively high and close to 1 (approximately 0.6-0.9 and up). The intercept of 639.32 and regression coefficient 6.6914 need to be considered from the standpoint of being statistically different from zero. A good test for that is P-**value**gt; (cells E17 and E18 in Table 5), which indicates a probability of the regression coefficient or the intercept to be different from zero. As a rule of thumb, if P-**value**gt; is smaller than 0.05 (or 5%), the regression coefficient (or intercept) is considered to be statistically different from zero. In our example, both the regression coefficient and intercept are significantly different from zero. The last parameter to consider is the F-statistic (cell E12), which defines the overall fit of the regression equation. To claim a good fit, the significance F (see Table 5, cell F12) should again be less than 0.05. In our example, the overall fit of the regression equation is very good, because the **value**gt; of significance F is substantially lower than 0.05.

According to all described parameters, the developed linear regression equation is statistically significant and can be used in forecasting. To develop this forecast, use the following formula in cell E2:=639.32+6.6914*C2 = 646 (Table 6), which represents the forecast for period 2. Copy this formula to cells E3:E25. The MADE **value**gt; of 2.7% indicates that the regression forecast has a very small average percentage error and may be successfully applied in business.

The steps described in building linear regression with one independent variable can also be employed in multiple regression forecasting with two or more independent variables.
CONCLUSION

Here we have demonstrated that Excel is quite capable of making use of several forecasting methods like moving average, exponential smoothing, and linear regression. However, it lacks certain features and enhancements that only specialized forecasting software have. The specified methods in Excel are only a subset of the forecasting methods used in business. Extra efforts will be needed to develop in Excel exponential smoothing with trend, and trend and seasonality (Holt's and Winter's models), time series decomposition and others. These methods, to be effectively used in Excel, would require additional dialog boxes or Excel add-ins.

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Copyright Journal of Business Forecasting Fall 2000

Descriptors: Forecasting techniques; Software
Classification Codes: 7100 (CN=Market research); 5240 (CN=Software & systems)
Print Media ID: 14886
Trade Names: Microsoft Excel

30/9/21 (Item 21 from file: 15)
02091647 64372340
Recent performance of the Canadian economy: A regional view

Amirault, David; Lafleur, Louis-Robert
Bank of Canada Review pp: 13-23

Autumn 2000
ISSN: 0045-1460 Journal Code: BCA
Document Type: Periodical; Feature Language: English Record Type: Fulltext Length: 11 Pages
Special Feature: Chart Graph Table
Word Count: 4897

Abstract:

This article outlines the activities of the Bank's regional offices and how regional economic **analysis** fits into the Bank's decision-making process. It describes how the offices gather anecdotal information and incorporate it in the Bank's analytic framework. It also reviews recent developments as well as prospects for future growth in the Canadian economy form a regional perspective.

Text:

While monetary policy is by nature national, regional economic **analysis** provides a central bank with one of many complementary views on economic conditions. Since 1997, the Bank's new regional offices have monitored regional economic developments. Through these offices, the Bank has improved communications with the general public and enhanced its information on current economic conditions.

Industry visits and quarterly surveys allow the Bank to probe business conditions and to receive timely feedback on topically important issues and on the effects of economic shocks. An industry association survey conducted in the summer of 2000 pointed to continued strength in the economy and the possibility of increasing pressures on capacity.

Recent regional economic performance is defined by the contrasting effects that the Asian crisis has had on Canada's five regions: the Atlantic provinces, Quebec, Ontario, the Prairies, and British Columbia. With the crisis over, all five regions are experiencing relatively good economic conditions, which has resulted in a buoyant national economy.

This article outlines the activities of the Bank's regional offices and how regional economic **analysis** fits into the Bank's decision-making process. The first section describes how the offices gather anecdotal information and incorporate it in the Bank's analytic framework. The second section reviews recent developments as well as prospects for future growth in the Canadian economy from a regional perspective.

Regional Economic Surveys
Given the lags in the effects of monetary policy on inflation and the uncertainty surrounding estimates of the output gap (defined as the difference between the observed level of demand and the unobserved economy's's potential to produce), the Bank of Canada has stressed, in recent Monetary Policy Reports, the growing importance for its policy deliberations of alternative measures of inflation pressures when assessing the upward and downward pressures on inflation. In recent years, the Bank has paid more attention to material collected through surveys and to other anecdotal information.2

Other central banks also make extensive use of surveys of business conditions in their decision-making process. In the United States, the Federal Reserve banks produce, on a rotational basis, the "Beige Book," a report of anecdotal information on current economic conditions in each Federal Reserve District collected through reports and interviews with key

business contacts, economists, market experts, and other sources. The Bank of England publishes the Agents' Summary of Business Conditions, which summarizes monthly reports compiled by the Bank of England's regional agents following discussions with about 1,700 businesses. The Bank of Japan produces the Tankan survey, a quarterly survey of approximately 10,000 private sector enterprises that assesses business conditions in Japan. At the Bank of Canada, surveys of business conditions are conducted by the Bank's regional offices.
The Bank of Canada's regional offices

The Bank of Canada has **historically** maintained a sizable regional presence across the country. Until recently, this was achieved through nine agencies located in major centres. The mandate of these agencies was primarily to distribute bank notes and deliver bonds and central banking services to **financial** institutions and the federal government. The Bank also operated offices in Montreal, Toronto, Vancouver, and, for a time, in Calgary and Edmonton, to monitor **financial** markets and execute open market operations with the **financial** community. Regional economic developments were monitored out of the Bank's head office in Ottawa by the Research Department. Head office staff also regularly visited industries across the regions to gather information on topical issues of particular concern, such as investment plans or wage and price pressures, and to gain insight into the economy to support ongoing research. As well, Bank staff would visit **financial** institutions to gather information relevant to understanding changes in money and credit aggregates.

Over time, the needs of the Bank changed and so did the nature of its regional presence. The advent of new technologies to deliver **financial** services greatly reduced the need for agencies across Canada. At the same time, the Bank needed more regional economic **analysis**, and its public communications became more important as it became a more open and transparent institution.

In 1996, after carefully considering more cost-effective ways to deliver its **financial** services, the Bank closed all but two agencies, keeping two large centres for bank note distribution in Verdun, Quebec and Mississauga, Ontario. At the same time, it opened two new regional offices and expanded the activities of the existing offices in Montreal, Toronto, and Vancouver, giving them the mandate to concentrate their activities in the areas of economic liaison and **analysis** and to oversee and support the operation of the **financial** services being carried out in conjunction with the private sector.3 Through these offices, the Bank wanted to strengthen its ties with industry, governments, educational institutions, associations, and the public. The five regional offices are: Atlantic Canada (Halifax); Quebec (Montreal); Ontario (Toronto); the Prairies, Northwest Territories, and Nunavut (Calgary); and British Columbia and the Yukon (Vancouver).

At each regional office, a team of two economists and administrative staff (who report directly to the Research Department at head office) is responsible for economic liaison and **analysis** in the region. This involves speaking to business groups, universities, and schools; participating in business meetings and conferences; and meeting with businesses, analysts, and government officials to broaden the Bank's understanding of the region and to explain developments in monetary policy. Regional offices also monitor regional economic developments and trends in commodity prices. The offices adopted the existing Research Department surveys as a framework but expanded their use to obtain an independent, bottomup assessment of growth prospects at the national level that could be used as a cross-check of modelbased staff projections.4

Gathering and reporting anecdotal information

When undertaking current **analysis** projects such as surveys, all five regional offices work together as a single team. They conduct four regional surveys per year timed to coincide with the Bank's quarterly economic projections. There are three surveys of individual firms and one survey of industry associations. Figure 1 shows the cycle of a typical survey.

The Bank of Canada's surveys are designed to identify the underlying trends in the economy through a mix of quantitative and qualitative anecdotal information collected during interviews. While the Bank's surveys are not as comprehensive as those done by Statistics Canada and the Conference Board of Canada, they are timely, forward-looking, and focused on issues relevant to monetary policy. In addition, responses are probed through direct conversations with survey participants.

The selection of the firms or associations to survey is reasonably simple. Each round of industry visits targets about 100 firms, while each round of industry-- association visits targets about 70 associations. The sample distribution is based on the composition of Canada's gross domestic product. Each regional office selects firms that they believe to be a good barometer of business conditions in their area. The aim is to achieve a good mix of small, medium, and large firms.

The survey questionnaire allows comparison of quantitative results over time. It includes questions about past and future sales from Canadian operations; prospects regarding inventories, investment, employment, labour costs, and prices; and expectations about inflation. Questions about constraints to capacity and the ability to meet unexpected demand were recently added to monitor whether the pressures on capacity are stable or growing. Each survey also includes supplementary questions dealing with topical issues of particular interest to the Bank and eliciting comments from respondents on monetary policy or other issues of concern to them. Recent supplementary questions concerned the effect of the depreciation of the Canadian dollar on output prices, an examination of how businesses were coping with the recent sharp rise in oil prices, and an assessment of the progress towards e-commerce and its impact on cost control.

The survey is sometimes carried out by telephone, but regional staff try to visit as many respondents as possible. Visits outside the major centres are also arranged regularly. Face-to-face visits are preferred, since they foster more broad-ranging discussions and allow Bank staff to see first-hand how businesses operate. The responses to the questionnaire are carefully handled to maintain strict confidentiality. Results of the five regional surveys are amalgamated to provide a national overview. Responses are tabulated in a format that helps to gauge the degree of momentum in the economy over the next few quarters. In the majority of responses, the results are presented as an unweighted balance of opinion; that is, the difference between the percentage of firms or associations who expect a given economic variable to be higher or to increase at a faster pace than in the previous year, minus the percentage who expect the variable to be lower or to grow at a slower pace. The balances of opinion can vary between +100 and -100. A strong positive balance of opinion suggests that survey respondents expect an acceleration in the trend growth rate over the previous period. Some of the survey questions try to identify underlying trends or the severity of a growing problem in the economy. Such a survey clearly has limitations. The small sample means that there are large confidence **intervals** around the sample results. The selection of firms is not completely **random**; since participation is voluntary, firms that are experiencing difficulties may be less likely to participate. The measure of momentum can, itself, also be misleading. For

example, a positive unweighted balance of opinion, coming mainly from small firms, would send the wrong signal if larger firms expected a slowdown. The interpretation of the results therefore requires informed judgment. In developing a consensus view of the survey results, the regional offices complement their **analysis** with additional information collected from their network of contacts and during external liaison activities.

Figure 1

The survey results are presented to senior management at about the same time as the quarterly staff economic projections. The survey provides expectations for key national economic variables, built up from the regional information, looking forward over the next 12 months. This view can be compared with the staff economic projections that are based on a structural macroeconomic model (the Quarterly Projection Model or QPM) adjusted by the judgment of analysts and by projections based on monetary aggregates. Significant differences between the outlooks would prompt further **analysis**. There is currently keen interest in any evidence from industry or association visits that would indicate a buildup in pressures on capacity or signs that capacity is being added at a faster rate than conventional measures or official statistics reveal. Concerns raised by senior management at the time of the presentation often sow the seeds for supplementary questions in the next survey.

Highlights from the summer 2000 survey of associations

Charts 1 and 2 present the results of the last five surveys for six key economic variables. The results of industry-association surveys are shown with those of firms, although the two may not be directly comparable. The latest association survey took place in June 2000. The regional offices contacted 66 industry associations across the country: 23 national associations and 43 provincial or regional associations. The main findings of the June survey are:

* The Canadian economy is likely to continue to grow at a robust, but slightly slower, pace over the next 12 months, since the momentum towards an acceleration in growth has diminished.

* Prospects for employment growth continue to be positive across all regions. This is contributing to an acceleration in wage growth, but respondents indicated that the increases would be moderate and that most would be matched by productivity gains.

* Input prices are expected to increase more than the previous year, mainly because of energyrelated cost increases. Other costs remain well contained.

* Output prices are not expected to rise as much as input prices because of productivity gains, continued strong competitive forces, and customer resistance to higher prices. Inflation expectations are well anchored, with 89 per cent of respondents expecting inflation to remain within the Bank of Canada's target range of 1 to 3 per cent over the next two years.
* There are growing signs of firms facing capacity constraints. While most firms are still able to work around the difficulties, there were severe constraints in a few industries.

* Strains on capacity are attributed mainly to a shortage of skilled labour. The number of skills in short supply has widened steadily over the past year. Firms and industry associations are actively pursuing innovative partnerships with schools and universities to deal with this growing problem. These findings contrast with recent surveys that suggest shortages of skilled labour are not a major concern of Canadian businesses. Nevertheless, the Bank of Canada's surveys clearly point towards an

intensification of difficulties in recruiting qualified personnel.

Recent Trends in Regional Economic Performance

In addition to carrying out quarterly surveys as a formal information-gathering tool, regional offices also engage in a wide range 6f contacts in industry and government. These contacts help the offices monitor events in regional economies and interpret trends in regional data. The quarterly survey results and information from liaison activities are combined with information from official statistics and surveys by Statistics Canada, the Conference Board of Canada, and other sources to assess regional economic developments and near-term prospects.
Chart 1

Chart 2

While regional economies broadly follow a national business cycle, they have their own key sectors, industries, and trading partners. Economic shocks therefore have different regional impacts, and, at any given time, regional cycles do not match the national trend. By monitoring each region, the Bank believes it can gain insights into the performance of the national economy and perhaps pick up advanced warning of shifts in the business cycle. The Asian **financial** crisis, together with its differential effects on Canada's regions, has been the key factor underpinning the relative performance of the five regions since 1997.5 With the recovery in most Asian countries in 1999 and 2000, there has been some convergence of regional economic performance towards the national average and, at the same time, an acceleration in overall growth.

The following description of the evolution of Canada's five regions since the Asian crisis is organized around the principal components of aggregate demand.

Foreign demand

From its peak in January 1997 and through the worst of the Asian crisis, the Bank of Canada's commodity price index (BCPI) fell 29 per cent.6 This decline was not evenly distributed across Canada's five regions (Chart 3). The indexes for British Columbia and the Prairies, which had risen in 1995 and 1996, fell 22 and 39 per cent, respectively, because of steep price reductions in key commodities such as crude oil, natural gas, lumber, pulp, grains and oilseeds, hogs, and some base metals. The Quebec and Ontario indexes fell 15 and 21 per cent, respectively. Weakness in prices for aluminum and other base metals, as well as for forestry products, caused most of the declines in these provinces. The Atlantic Canada index suffered the least, decreasing by only 1.4 per cent, with higher prices for fish, lobster, and potatoes largely offsetting lower prices for pulp, iron ore, and zinc.

In addition to declining prices for key commodities, export volumes suffered as direct Asian demand for Canadian products softened. Again, British Columbia and the Prairies suffered the brunt of the collapse. In 1997, both regions depended on Asian demand for a relatively large portion of total exports, 34 and 13 per cent, respectively (Chart 4). In contrast, central Canadian exports to Asia amounted to less than 4 per cent of total international exports in 1997. Evidence on the regional effects of the Asian crisis in the United States suggests that the western states, much like the western Canadian provinces, were also more severely affected by the Asian crisis (Coughlin and Pollard 2000).
By 1999, the first full year after the Asian crisis, regional trade flows had shifted. Continued weakness in Asian markets and the relative weakness of other global markets, compared with the booming market in the United

States, had drawn an increasing proportion of Canadian goods towards our largest trading partner. Exports to the northeastern and southern states, in particular, have become a larger portion of total exports in all five Canadian regions. Eastern Canada, with its already strong trade links in the northeastern and central United States, not only suffered the least from the direct effects of the Asian crisis, but also was well positioned to benefit from the strength of U.S. demand, particularly for automotive products, transportation, and telecommunications equipment.

Investment spending

From 1992 to 1998, investment spending has been the fastest-growing component of demand in all regions except British Columbia (Table 1). The trend has been particularly strong in the Prairies and the Atlantic provinces. In recent years, both regions have benefited from investment in large-scale energy projects and their related transportation infrastructure. These included the Alliance pipeline, the Sable Gas project, and the Terra Nova oil project. British Columbia's performance was held back by lingering softness in mining and forestry and by a reversal of capital inflows from Hong Kong in the wake of a smooth handover to China on 1 July 1997.

Chart 3

Chart 4

In Quebec and Ontario, non-residential construction activity, which had been stagnant since the beginning of the economic recovery in 1992 (Chart 5), partly because of a hangover from the overbuilding of office space in the late 1980s, has started to accelerate. Vacancy rates for office space in Canada's large cities have dropped rapidly over the last three years, and the national office vacancy rate, as recorded by Royal LePage, stands at an **historical** low of 7.4 per cent in the second quarter of 2000, down a full 2 percentage points from a year ago. Over the medium term, demand for new office space and the expansion of transportation infrastructure around major cities are expected to help fuel non-residential construction. Growth in spending on machinery and equipment has been stronger since 1996 across all five regions (Chart 6). A series of retooling projects at auto plants, two metalprocessing projects in Quebec, and the adoption of new technologies by manufacturing firms in Quebec and Ontario have provided a solid base for growth in central Canada over the past few years.

Consumer spending

Table 1

Chart 5

Chart 6

Western Canada-particularly British Columbia-- enjoyed strong growth in consumer spending in the early to mid-1990s, when the economic climate was quite buoyant. This growth, driven at least partially by an influx of people and wealth from Asia, waned during and after the Asian crisis. More recently, consumer spending has been significantly stronger in eastern Canada than in western Canada. In 1999, the average growth of retail sales in provinces east of the Manitoba border was 7 per cent compared with less than 3 per cent in western provinces.

One key reason for this west-to-east shift in consumer spending has been the contrasting effect that the Asian crisis has had on consumer confidence in different parts of Canada (Chart 7). The Conference Board of Canada's survey of consumer confidence (Index of Consumer Attitudes) captures the

decline in confidence among consumers in western Canada throughout 1998. In contrast, confidence among eastern Canadian consumers fell initially but soon regained momentum and reached peak levels in 1999 and early 2000. As explained earlier, to the extent that the northeastern and central United States were aided by low commodity prices during the crisis, the eastern Canadian provinces that trade heavily with them have benefited. It appears that some of the downstream effects of this trend also indirectly boosted consumer confidence in eastern Canada.

The latest surveys suggest that consumer confidence among western Canadians has improved (although not to the levels reached prior to the Asian crisis) and remains at a high level in central Canada. In Atlantic Canada, consumer confidence has retreated since the second quarter of 1999. All regions have seen improving labour markets in 1999 and in the first half of 2000. Coupled with expected wage growth, overall labour income will expand. Furthermore, consumers will retain more of their income, given announced reductions in both federal and provincial income taxes.

Provincial government spending

Because of a concerted effort to reduce and eliminate federal and provincial budget deficits, government expenditures on goods and services have been flat, on average, since 1992 (Table 1). More recently, with budgets largely balanced, government priorities have turned to two other issues. Tax reductions are a key theme in most provincial budgets this year. As well, some provinces plan to increase spending in specific areas such as health, education, and infrastructure. Many provinces are also moving to decouple their income tax structures from the federal structure. Few provincial governments have made specific commitments to debt retirement or to targets for their debt-toGDP ratios, focusing instead on short- and mediumterm commitments to tax reductions and modest plans for additional spending. Some provinces have also focused on zero-deficit legislation.

In central Canada, both Ontario and Quebec have proposed a series of tax reductions. Quebec's plan would see reductions of $4.5 billion spread over three years. Reductions are already well underway in Ontario, where the income tax rate declined from 58 per cent of basic federal tax in 1995 to 38.5 per cent in 2000. Both provincial governments are forecasting another year of balanced budgets in 2000/01, and both have initiated new spending measures focused mainly on health care, education, and infrastructure projects. The three Prairie provinces have run balanced budgets for the past several years. This favourable fiscal position has been maintained despite deteriorating economic conditions in the wake of the Asian crisis. Manitoba and Saskatchewan expect a small surplus in 2000/01, while Alberta's surplus is now expected to be $5 billion. The Prairies' public debt has fallen from over 30 per cent to less than 20 per cent of GDP. Alberta has made the largest contribution to this trend, having recently eliminated its net debt.

Prince Edward Island and Newfoundland have managed to significantly improve their fiscal positions in the past few budget years, partly because of strong revenue growth in robust economies. Meanwhile, Nova Scotia and New Brunswick have revised their accounting practices to more accurately reflect the state of provincial **finances**. New Brunswick is now expecting to record a $21 million surplus in 2000/01. Nova Scotia is expecting a deficit of $268 million in 2000/01, a marked improvement from the $765 million deficit recorded in 1999/2000. In British Columbia, a $1.1 billion deficit for 1999/2000 has recently been revised to a $52 million surplus, and a balanced budget is expected in 2000/2001.

Wages and prices

Chart 7

Wage settlements have moved up moderately in all regions except British Columbia. From 1998 to 1999, wage growth in an average agreement rose from 1.7 to 2.2 per cent. The momentum was slightly stronger in private sector agreements and in settlements in Manitoba and Alberta. For example, private sector agreements in Alberta averaged 5.1 per cent in 1999. More recently, average private and public sector wage increases ranged from 0.6 per cent in British Columbia to 3.8 per cent in neighbouring Alberta. Wage settlements in eastern Canada are close to the national average of 2.3 per cent.

Increases in the consumer price index (all items) have recently ranged from 1.5 per cent in British Columbia to 4.8 per cent in Prince Edward Island. This index has been heavily influenced by the differential regional effects of recent increases in energy costs. The spectrum of consumer price inflation when food and energy are excluded is much less variable from province to province, ranging from 0.9 per cent in British Columbia to 1.8 per cent in Alberta. British Columbia has had one of the lowest inflation records since 1996, owing to slow economic growth, a tuition freeze, and weak housing costs. This represents a strong reversal of the situation in the early 1990s when British Columbia consistently posted the highest inflation in the country, as high output growth put pressure on capacity.

Prospects and risks

Prior to the Asian crisis, western Canada (west of Ontario) led the economic recovery from the 1990-91 recession. In January 1997, for example, the unemployment rate in eastern Canada (east of Manitoba) was much higher than in western Canada (Chart 8). During and after the Asian economic crisis, major sectors in the Prairies and British Columbia suffered setbacks, and unemployment rates in western Canada remained stuck at 7 per cent. In contrast, eastern Canada benefited from the strong pace of expansion in the United States, and unemployment rates fell rapidly. With the crisis now over, economic conditions have remained robust, or are improving quickly, across all five regions. Regional labour markets continued to gain strength in 1999 and the first half of 2000. Consumer spending will likely continue to respond to these stronger labour market conditions. Central Canadian (Ontario and Quebec) consumers are expected to continue to contribute heavily to overall growth in household consumption this year and beyond. Consumer spending in Alberta is expected to grow at rates close to those of central Canada, driven by very strong gains in both population and incomes. In the other western provinces, consumer spending is expected to rebound slowly as economic conditions in Manitoba, Saskatchewan, and British Columbia improve. In Atlantic Canada, retail sales growth remains close to the national average.

Chart 8

Foreign demand for Canadian goods and services is expected to remain a solid source of output growth in 2000. While agricultural and lumber prices have come under some downward pressure, international prices for other Canadian-produced commodities (such as oil, natural gas, and base metals) have strengthened over the past year. For the oil and gas sector, these factors are already spilling over into better-than-anticipated exploration and investment activity. Investment intentions for Alberta are 8.4 per cent higher this year than investment levels in 1999. Lower office vacancy rates in major Canadian cities are also expected to generate commercial construction activity this year and next. Growth in investment intentions in Quebec and Ontario for 2000 is 5.4 per cent and 7.5 per cent, respectively. On the other hand, several major projects hit peak

construction levels during 1999. This could dampen growth for 2000 in the provinces affected-- Manitoba, Saskatchewan, and the Atlantic provinces. Public and private investment in British Columbia is expected to grow by 5.3 per cent in 2000.

While the strength and sources of output growth vary from region to region across Canada, all five regions share the risks that have recently been highlighted in the Bank's Monetary Policy Report. These risks pertain primarily to greater pressures on capacity as Canada's output gap narrows because of strong demand from foreign and domestic sources. As discussed above, a growing list of firms, industry associations, and key regional contacts also point to shortages. In particular, labour shortages, which were once limited to hightech industries, are now broadening to include the construction trades, truck transportation, engineering, food services, and accommodation. Assessing the evolution of these risks to the Canadian economic expansion will continue to be a focus of regional liaison activities in the months ahead.

1. The uncertainty surrounding the output gap estimate was discussed in Technical Box 4 in the May 1999 Monetary Policy Report. For a discussion on monitoring inflation pressures, see Technical Box 4 in the November 1999 Monetary Policy Report.

2. An example of other issues explored by regional offices through surveys or interviews is an **analysis** of the effects of restructuring on the Canadian economy summarized in Kwan (2000).

3. For more information on the opening of regional offices, see the Bank of Canada press release dated 23 April 1997; for information on the closing of the Bank's agencies, see the Bank of Canada press release dated 17 July 1996.

4. For a description of the role of model-based staff projections in the conduct of monetary policy, see Poloz et al. (1994).

5. For a discussion of the Asian **financial** crisis and its effects, see Technical Box 3 of the May 1998 Monetary Policy Report.

6. For a more complete discussion of movements in the BCPI during the Asian crisis, see Novin and Stuber (1999).

7. Source: Royal LePage. National Office Report, 2nd Quarter 2000.

8. Wage-settlement data are obtained from The Wage Settlements Bulletin produced by Human Resources Development Canada. This report's coverage of wage settlements is estimated to be 55 per cent of the unionized workforce and 20 per cent of the non-agricultural, paid, employed workforce.

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We wish to thank Allan Paquet, Mark Illing, and Anne Gillan of the Atlantic Regional Office, Jane Pinto of the Ontario Regional Office, and Debbie Dandy and Anne Sung in Ottawa for their excellent research assistance.

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Company Names:
Bank of Canada (Duns: 20-787-9677 NAICS:521110)
Geographic Names: Canada

Descriptors: Banks; Economic statistics; Regions; Decision making; Economic forecasts; Polls & surveys
Classification Codes: 1110 (CN=Economic conditions & forecasts); 9140 (CN=Statistical data); 8100 (CN=Financial services industry); 9172 (CN=Canada)
Print Media ID: 26748

30/9/22 (Item 22 from file: 148)
13393408 Supplier Number: 69066727 (THIS IS THE FULL TEXT)
Notes on Current Labor Statistics.(Statistical Data Included)

Monthly Labor Review , 123 , 10 , 48
Oct , 2000
Document Type: Statistical Data Included
ISSN: 0098-1818
Language: English
Record Type: Fulltext
Word Count: 27301 Line Count: 08883

Text:

This section of the Review presents the principal statistical series collected and calculated by the Bureau of Labor Statistics: series on labor force; employment; unemployment; labor compensation; consumer, producer, and international prices; productivity; international comparisons; and injury and illness statistics. In the notes that follow, the data in each group of tables are briefly described; key definitions are given; notes on the data are set forth; and sources of additional information are cited.

General notes

The following notes apply to several tables in this section:

Seasonal adjustment. Certain monthly and quarterly data are adjusted to eliminate the effect on the data of such factors as climatic conditions, industry production schedules, opening and closing of schools, holiday buying periods, and vacation practices, which might prevent short-term evaluation of the statistical series. Tables containing data that have been adjusted are identified as "seasonally adjusted." (All other data are not seasonally adjusted.) Seasonal effects are estimated on the basis of past experience. When new seasonal factors are computed each year, revisions may affect seasonally adjusted data for several preceding years.

Seasonally adjusted data appear in tables 1-14, 16-17, 39, and 43. Seasonally adjusted labor force data in tables 1 and 4-9 were revised in the February 2000 issue of the Review. Seasonally adjusted establishment survey data shown in tables 1, 12-14 and 1617 were revised in the July 2000 Review and reflect the experience through March 2000. A brief explanation of the seasonal adjustment methodology appears in "Notes on the data."

Revisions in the productivity data in table 45 are usually introduced in the September issue. Seasonally adjusted indexes and percent changes from month-to-month and quarter-to-quarter are published for numerous Consumer and Producer Price Index series. However, seasonally adjusted indexes are not published for the U.S. average All-Item CPI. Only seasonally adjusted percent changes are available for this series.

Adjustments for price changes. Some data--such as the "real" earnings shown in table 14--are adjusted to eliminate the effect of changes in price. These adjustments are made by dividing current-dollar values by the Consumer Price Index or the appropriate component of the index, then multiplying by 100. For example, given a current hourly wage rate of $3 and a current price index number of 150, where 1982 -- 100, the hourly rate expressed in 1982 dollars is $2 ($3/150 x 100 = $2). The $2 (or any other resulting values) are described as "real," "constant," or "1982" dollars.

Sources of information

Data that supplement the tables in this section are published by the Bureau in a variety of sources. Definitions of each series and notes on the data are contained in later sections of these Notes describing each set of data. For detailed descriptions of each data series, see BLS Handbook of Methods, Bulletin 2490. Users also may wish to consult Major Programs of the Bureau of Labor Statistics, Report 919. News releases provide the latest statistical information published by the Bureau; the major recurring releases are published according to the schedule appearing on the back cover of this issue.

More information about labor force, employment, and unemployment data and the household and establishment surveys underlying the data are available in the Bureau's monthly publication, Employment and Earnings. Historical unadjusted and seasonally adjusted data from the household survey are available on the Internet:

http://stats.bls.gov/cpshome.htm

Historically comparable unadjusted and seasonally adjusted data from the establishment survey also are available on the Internet:

http://stats.bls.gov/ceshome.htm

Additional information on labor force data for areas below the national level are provided in the BLS annual report, Geographic Profile of Employment and Unemployment.

For a comprehensive discussion of the Employment Cost Index, see Employment Cost Indexes and Levels, 1975-95, BLS Bulletin 2466. The most recent data from the Employee Benefits Survey appear in the following Bureau of Labor Statistics bulletins: Employee Benefits in Medium and Large Firms; Employee Benefits in Small Private Establishments; and Employee Benefits in State and Local Governments.

More detailed data on consumer and producer prices are published in the monthly periodicals, The CPI Detailed Report and Producer Price Indexes. For an overview of the 1998 revision of the CPI, see the December 1996 issue of the Monthly Labor Review. Additional data on international

prices appear in monthly news releases.

Listings of industries for which productivity indexes are available may be found on the Internet:

http://stats.bls.gov/iprhome.htm

For additional information on international comparisons data, see International Comparisons of Unemployment, BLS Bulletin 1979.

Detailed data on the occupational injury and illness series are published in Occupational Injuries and Illnesses in the United States, by Industry, a BLS annual bulletin.

Finally, the Monthly Labor Review carries analytical articles on annual and longer term developments in labor force, employment, and unemployment; employee compensation and collective bargaining; prices; productivity; international comparisons; and injury and illness data.

Symbols

n.e.c. = not elsewhere classified.

n.e.s. = not elsewhere specified.

p = preliminary. To increase the timeliness of some series, preliminary figures are issued based on representative but incomplete returns.

r = revised. Generally, this revision reflects the availability of later data, but also may reflect other adjustments.

Comparative Indicators

(Tables 1-3)

Comparative indicators tables provide an overview and comparison of major BLS statistical series. Consequently, although many of the included series are available monthly, all measures in these comparative tables are presented quarterly and annually.

Labor market indicators include employment measures from two major surveys and information on rates of change in compensation provided by the Employment Cost Index (ECI) program. The labor force participation rate, the employment-to-population ratio, and unemployment rates for major demographic groups based on the Current Population ("household") Survey are presented, while measures of employment and average weekly hours by major industry sector are given using nonfarm payroll data. The Employment Cost Index (compensation), by major sector and by bargaining status, is chosen from a variety of BLS compensation and wage measures because it provides a comprehensive measure of employer costs for hiring labor, not just outlays for wages, and it is not affected by employment shifts among occupations and industries.

Data on changes in compensation, prices, and productivity are presented in table 2. Measures of rates of change of compensation and wages from the Employment Cost Index program are provided for all civilian nonfarm workers (excluding Federal and household workers) and for all private nonfarm workers. Measures of changes in consumer prices for all urban consumers; producer prices by stage of processing; overall prices by stage of processing; and overall export and import price indexes are given. Measures of productivity (output per hour of all persons) are provided for major sectors.

Alternative measures of wage and compensation rates of change, which reflect the overall trend in labor costs, are summarized in table 3. Differences in concepts and scope, related to the specific purposes of the series, contribute to the variation in changes among the individual measures.

Notes on the data

Definitions of each series and notes on the data are contained in later sections of these notes describing each set of data.

Employment and Unemployment Data

(Tables 1; 4-20)

Household survey data

Description of the series

EMPLOYMENT DATA in this section are obtained from the Current Population Survey, a program of personal interviews conducted monthly by

the Bureau of the Census for the Bureau of Labor Statistics. The sample consists of about 50,000 households selected to represent the U.S. population 16 years of age and older. Households are interviewed on a rotating basis, so that three-fourths of the sample is the same for any 2 consecutive months.

Definitions

Employed persons include (1) all those who worked for pay any time during the week which includes the 12th day of the month or who worked unpaid for 15 hours or more in a family-operated enterprise and (2) those who were temporarily absent from their regular jobs because of illness, vacation, industrial dispute, or similar reasons. A person working at more than one job is counted only in the job at which he or she worked the greatest number of hours.

Unemployed persons are those who did not work during the survey week, but were available for work except for temporary illness and had looked for jobs within the preceding 4 weeks. Persons who did not look for work because they were on layoff are also counted among the unemployed. The unemployment rate represents the number unemployed as a percent of the civilian labor force.

The civilian labor force consists of all employed or unemployed persons in the civilian noninstitutional population. Persons not in the labor force are those not classified as employed or unemployed. This group includes discouraged workers, defined as persons who want and are available for a job and who have looked for work sometime in the past 12 months (or since the end of their last job if they held one within the past 12 months), but are not currently looking, because they believe there are no jobs available or there are none for which they would qualify. The civilian noninstitutional population comprises all persons 16 years of age and older who are not inmates of penal or mental institutions, sanitariums, or homes for the aged, infirm, or needy. The civilian labor force participation rate is the proportion of the civilian noninstitutional population that is in the labor force. The employment-population ratio is employment as a percent of the civilian noninstitutional population.

Notes on the data

From time to time, and especially after a decennial census, adjustments are made in the Current Population Survey figures to correct for estimating errors during the intercensal years. These adjustments affect the comparability of historical data. A description of these adjustments and their effect on the various data series appears in the Explanatory Notes of Employment and Earnings.

Data beginning; in 2000 are not strictly comparable with data for 1999 and earlier years because of the introduction of revised population controls. Additional information appears in the February 2000 issue of Employment and Earnings.

Labor force data in tables 1 and 4-9 are seasonally adjusted. Since January 1980, national labor force data have been seasonally adjusted with a procedure called X-11 ARIMA which was developed at Statistics Canada as an extension of the standard X-11 method previously used by BLS. A detailed description of the procedure appears in the X-11 ARIMA Seasonal Adjustment Method, by Estela Bee Dagum (Statistics Canada, Catalogue No. 12-564E, January 1983).

At the beginning of each calendar year, historical seasonally adjusted data usually are revised, and projected seasonal adjustment factors are calculated for use during the January-June period. The historical seasonally adjusted data usually are revised for only the most recent 5 years. In July, new seasonal adjustment factors, which incorporate the experience through June, are produced for the July-December period, but no revisions are made in the historical data.

FOR ADDITIONAL INFORMATION on national household survey data, contact the Division of Labor Force Statistics: (202) 691-6378.

Establishment survey data

Description of the series

EMPLOYMENT, HOURS, AND EARNINGS DATA in this section are compiled from payroll records reported monthly on a voluntary basis to the Bureau of Labor Statistics and its cooperating State agencies by about 300,000 establishments representing all industries except agriculture. Industries are classified in accordance with the 1987 Standard Industrial Classification (SIC) Manual. In most industries, the sampling probabilities are based on the size of the establishment; most large establishments are therefore in the sample. (An establishment is not necessarily a firm; it may be a branch plant, for example, or warehouse.) Self-employed persons and others not on a regular civilian payroll are outside the scope of the survey because they are excluded from establishment records. This largely accounts for the difference in employment figures between the household and establishment surveys.

Definitions

An establishment is an economic unit which produces goods or services (such as a factory or store) at a single location and is engaged in one type of economic activity.

Employed persons are all persons who received pay (including holiday and sick pay) for any part of the payroll period including the 12th day of the month. Persons holding more than one job (about 5 percent of all persons in the labor force) are counted in each establishment which reports them.

Production workers in manufacturing include working supervisors and nonsupervisory workers closely associated with production operations. Those workers mentioned in tables 11-16 include production workers in manufacturing and mining; construction workers in construction; and nonsupervisory workers in the following industries: transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; and services. These groups account for about four-fifths of the total employment on private nonagricultural payrolls.

Earnings are the payments production or nonsupervisory workers receive during the survey period, including premium pay for overtime or late-shift work but excluding irregular bonuses and other special payments. Real earnings are earnings adjusted to reflect the effects of changes in consumer prices. The deflator for this series is derived from the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W).

Hours represent the average weekly hours of production or nonsupervisory workers for which pay was received, and are different from standard or scheduled hours. Overtime hours represent the portion of average weekly hours which was in excess of regular hours and for which overtime premiums were paid.

The Diffusion Index represents the percent of industries in which employment was rising over the indicated period, plus one-half of the industries with unchanged employment; 50 percent indicates an equal balance between industries with increasing and decreasing employment. In line with Bureau practice, data for the 1-, 3-, and 6-month spans are seasonally adjusted, while those for the 12-month span are unadjusted. Data are centered within the span. Table 17 provides an index on private nonfarm employment based on 356 industries, and a manufacturing index based on 139 industries. These indexes are useful for measuring the dispersion of economic gains or losses and are also economic indicators.

Notes on the data

Establishment survey data are annually adjusted to comprehensive counts of employment (called "benchmarks"). The latest adjustment, which incorporated March 1999 benchmarks, was made with the release of May 2000 data, published in the July 2000 issue of the Review. Coincident with the benchmark adjustment, historical seasonally adjusted data were revised to reflect updated seasonal factors. Unadjusted data from April 1999 forward and seasonally adjusted data from January 1996 forward are subject to revision in future benchmarks.

In addition to the routine benchmark revisions and updated seasonal factors introduced with the release of the May 2000 data, all estimates for

the wholesale trade division from April 1998 forward were revised to incorporate a new sample design. This represented the first major industry division to convert to a probability-based sample under a 4-year phase-in plan for the establishment survey sample redesign project. For additional information, see the the June 2000 issue of Employment and Earnings.

Revisions in State data (table 11) occurred with the publication of January 2000 data. Beginning in June 1996, the BLS uses the X-12 ARIMA methodology to seasonally adjust establishment survey data. This procedure, developed by the Bureau of the Census, controls for the effect of varying survey intervals (also known as the 4- versus 5-week effect), thereby providing improved measurement of over-the-month changes and underlying economic trends. Revisions of data, usually for the most recent 5-year period, are made once a year coincident with the benchmark revisions.

In the establishment survey, estimates for the most recent 2 months are based on incomplete returns and are published as preliminary in the tables (12-17 in the Review). When all returns have been received, the estimates are revised and published as "final" (prior to any benchmark revisions) in the third month of their appearance. Thus, December data are published as preliminary in January and February and as final in March. For the same reasons, quarterly establishment data (table 1) are preliminary for the first 2 months of publication and final in the third month. Thus, fourth-quarter data are published as preliminary in January and February and as final in March.

FOR ADDITIONAL INFORMATION on establishment survey data, contact the Division of Monthly Industry Employment Statistics: (202) 691-6555.

Unemployment data by State

Description of the series

Data presented in this section are obtained from the Local Area Unemployment Statistics (LAUS) program, which is conducted in cooperation with State employment security agencies.

Monthly estimates of the labor force, employment, and unemployment for States and sub-State areas are a key indicator of local economic conditions, and form the basis for determining the eligibility of an area for benefits under Federal economic assistance programs such as the Job Training Partnership Act. Seasonally adjusted unemployment rates are presented in table 10. Insofar as possible, the concepts and definitions underlying these data are those used in the national estimates obtained from the CPS.

Notes on the data

Data refer to State of residence. Monthly data for all States and the District of Columbia are derived using standardized procedures established by BLS. Once a year, estimates are revised to new population controls, usually with publication of January estimates, and benchmarked to annual average CPS levels.

FOR ADDITIONAL INFORMATION on data in this series, call (202) 691-6392 (table 10) or (202) 691-6559 (table 11).

Compensation and Wage Data

(Tables 1-3; 21-27)

COMPENSATION AND WAGE DATA are gathered by the Bureau from business establishments, State and local governments, labor unions, collective bargaining agreements on file with the Bureau, and secondary sources.

Employment Cost Index

Description of the series

The Employment Cost Index (ECI) is a quarterly measure of the rate of change in compensation per hour worked and includes wages, salaries, and employer costs of employee benefits. It uses a fixed market basket of labor--similar in concept to the Consumer Price Index's fixed market basket of goods and services--to measure change over time in employer costs of employing labor.

Statistical series on total compensation costs, on wages and salaries, and on benefit costs are available for private nonfarm workers excluding proprietors, the self-employed, and household workers. The total

compensation costs and wages and salaries series are also available for State and local government workers and for the civilian nonfarm economy, which consists of private industry and State and local government workers combined. Federal workers are excluded.

The Employment Cost Index probability sample consists of about 4,400 private nonfarm establishments providing about 23,000 occupational observations and 1,000 State and local government establishments providing 6,000 occupational observations selected to represent total employment in each sector. On average, each reporting unit provides wage and compensation information on five well-specified occupations. Data are collected each quarter for the pay period including the 12th day of March, June, September, and December.

Beginning with June 1986 data, fixed employment weights from the 1980 Census of Population are used each quarter to calculate the civilian and private indexes and the index for State and local governments. (Prior to June 1986, the employment weights are from the 1970 Census of Population.) These fixed weights, also used to derive all of the industry and occupation series indexes, ensure that changes in these indexes reflect only changes in compensation, not employment shifts among industries or occupations with different levels of wages and compensation. For the bargaining status, region, and metropolitan/non-metropolitan area series, however, employment data by industry and occupation are not available from the census. Instead, the 1980 employment weights are reallocated within these series each quarter based on the current sample. Therefore, these indexes are not strictly comparable to those for the aggregate, industry, and occupation series.

Definitions

Total compensation costs include wages, salaries, and the employer's costs for employee benefits.

Wages and salaries consist of earnings before payroll deductions, including production bonuses, incentive earnings, commissions, and cost-of-living adjustments.

Benefits include the cost to employers for paid leave, supplemental pay (including nonproduction bonuses), insurance, retirement and savings plans, and legally required benefits (such as Social Security, workers' compensation, and unemployment insurance).

Excluded from wages and salaries and employee benefits are such items as payment-in-kind, free room and board, and tips.

Notes on the data

The Employment Cost Index for changes in wages and salaries in the private nonfarm economy was published beginning in 1975. Changes in total compensation cost--wages and salaries and benefits combined--were published beginning in 1980. The series of changes in wages and salaries and for total compensation in the State and local government sector and in the civilian nonfarm economy (excluding Federal employees) were published beginning in 1981. Historical indexes (June 1981=100) are available on the Internet:

http://stats.bls.gov/ecthome.htm

FOR ADDITIONAL INFORMATION on the Employment Cost Index, contact the Office of Compensation Levels and Trends: (202) 691-6199.

Employee Benefits Survey

Description of the series

Employee benefits data are obtained from the Employee Benefits Survey, an annual survey of the incidence and provisions of selected benefits provided by employers. The survey collects data from a sample of approximately 9,000 private sector and State and local government establishments. The data are presented as a percentage of employees who participate in a certain benefit, or as an average benefit provision (for example, the average number of paid holidays provided to employees per year). Selected data from the survey are presented in table 25 for medium and large private establishments and in table 26 for small private establishments and State and local government.

The survey covers paid leave benefits such as holidays and vacations, and personal, funeral, jury duty, military, family, and sick leave; short-term disability, long-term disability, and life insurance; medical, dental, and vision care plans; defined benefit and defined contribution plans; flexible benefits plans; reimbursement accounts; and unpaid family leave.

Also, data are tabulated on the incidence of several other benefits, such as severance pay, child-care assistance, wellness programs, and employee assistance programs.

Definitions

Employer-provided benefits are benefits that are financed either wholly or partly by the employer. They may be sponsored by a union or other third party, as long as there is some employer financing. However, some benefits that are fully paid for by the employee also are included. For example, long-term care insurance and postretirement life insurance paid entirely by the employee are included because the guarantee of insurability and availability at group premium rates are considered a benefit.

Participants are workers who are covered by a benefit, whether or not they use that benefit. If the benefit plan is financed wholly by employers and requires employees to complete a minimum length of service for eligibility, the workers are considered participants whether or not they have met the requirement. If workers are required to contribute towards the cost of a plan, they are considered participants only if they elect the plan and agree to make the required contributions.

Defined benefit pension plans use predetermined formulas to calculate a retirement benefit (if any), and obligate the employer to provide those benefits. Benefits are generally based on salary, years of service, or both.

Defined contribution plans generally specify the level of employer and employee contributions to a plan, but not the formula for determining eventual benefits. Instead, individual accounts are set up for participants, and benefits are based on amounts credited to these accounts.

Tax-deferred savings plans are a type of defined contribution plan that allow participants to contribute a portion of their salary to an employer-sponsored plan and defer income taxes until withdrawal.

Flexible benefit plans allow employees to choose among several benefits, such as life insurance, medical care, and vacation days, and among several levels of coverage within a given benefit.

Notes on the data

Surveys of employees in medium and large establishments conducted over the 1979-86 period included establishments that employed at least 50, 100, or 250 workers, depending on the industry (most service industries were excluded). The survey conducted in 1987 covered only State and local governments with 50 or more employees. The surveys conducted in 1988 and 1989 included medium and large establishments with 100 workers or more in private industries. All surveys conducted over the 1979-89 period excluded establishments in Alaska and Hawaii, as well as part-time employees.

Beginning in 1990, surveys of State and local governments and small private establishments were conducted in even-numbered years, and surveys of medium and large establishments were conducted in odd-numbered years. The small establishment survey includes all private nonfarm establishments with fewer than 100 workers, while the State and local government survey includes all governments, regardless of the number of workers. All three surveys include full- and part-time workers, and workers in all 50 States and the District of Columbia.

FOR ADDITIONAL INFORMATION on the Employee Benefits Survey, contact the Office of Compensation Levels and Trends on the Internet:

http://stats.bls.gov/ebshome.htm

Work stoppages

Description of the series

Data on work stoppages measure the number and duration of major strikes or lockouts (involving 1,000 workers or more) occurring during the

month (or year), the number of workers involved, and the amount of work time lost because of stoppage. These data are presented in table 27.

Data are largely from a variety of published sources and cover only establishments directly involved in a stoppage. They do not measure the indirect or secondary effect of stoppages on other establishments whose employees are idle owing to material shortages or lack of service.

Definitions

Number of stoppages: The number of strikes and lockouts involving 1,000 workers or more and lasting a full shift or longer.

Workers involved: The number of workers directly involved in the stoppage.

Number of days idle: The aggregate number of workdays lost by workers involved in the stoppages.

Days of idleness as a percent of estimated working time: Aggregate workdays lost as a percent of the aggregate number of standard workdays in the period multiplied by total employment in the period.

Notes on the data

This series is not comparable with the one terminated in 1981 that covered strikes involving six workers or more.

FOR ADDITIONAL INFORMATION on work stoppages data, contact the Office of Compensation and Working Conditions: (202) 691-6282, or the Internet:

http://stats.bls.gov/cbahome.htm

Price Data

(Tables 2; 28-38)

PRICE DATA are gathered by the Bureau of Labor Statistics from retail and primary markets in the United States. Price indexes are given in relation to a base period--1982 = 100 for many Producer Price Indexes, 1982-84 = 100 for many Consumer Price Indexes (unless otherwise noted), and 1990 = 100 for International Price Indexes.

Consumer Price Indexes

Description of the series

The Consumer Price Index (CPI) is a measure of the average change in the prices paid by urban consumers for a fixed market basket of goods and services. The CPI is calculated monthly for two population groups, one consisting only of urban households whose primary source of income is derived from the employment of wage earners and clerical workers, and the other consisting of all urban households. The wage earner index (CPI-W) is a continuation of the historic index that was introduced well over a half-century ago for use in wage negotiations. As new uses were developed for the CPI in recent years, the need for a broader and more representative index became apparent. The all-urban consumer index (CPI-U), introduced in 1978, is representative of the 1993-95 buying habits of about 87 percent of the noninstitutional population of the United States at that time, compared with 32 percent represented in the CPI-W. In addition to wage earners and clerical workers, the CPI-U covers professional, managerial, and technical workers, the self-employed, short-term workers, the unemployed, retirees, and others not in the labor force.

The CPI is based on prices of food, clothing, shelter, fuel, drugs, transportation fares, doctors' and dentists' fees, and other goods and services that people buy for day-to-day living. The quantity and quality of these items are kept essentially unchanged between major revisions so that only price changes will be measured. All taxes directly associated with the purchase and use of items are included in the index.

Data collected from more than 23,000 retail establishments and 5,800 housing units in 87 urban areas across the country are used to develop the "U.S. city average." Separate estimates for 14 major urban centers are presented in table 29. The areas listed are as indicated in footnote 1 to the table. The area indexes measure only the average change in prices for each area since the base period, and do not indicate differences in the level of prices among cities.

Notes on the data

In January 1983, the Bureau changed the way in which homeownership costs are measured for the CPI-U. A rental equivalence method replaced the asset-price approach to homeownership costs for that series. In January 1985, the same change was made in the CPI-W. The central purpose of the change was to separate shelter costs from the investment component of home-ownership so that the index would reflect only the cost of shelter services provided by owner-occupied homes. An updated CPI-U and CPI-W were introduced with release of the January 1987 and January 1998 data.

FOR ADDITIONAL INFORMATION on consumer prices, contact the Division of Consumer Prices and Price Indexes: (202) 691-7000.

Producer Price Indexes

Description of the series

Producer Price Indexes (PPI) measure average changes in prices received by domestic producers of commodities in all stages of processing. The sample used for calculating these indexes currently contains about 3,200 commodities and about 80,000 quotations per month, selected to represent the movement of prices of all commodities produced in the manufacturing; agriculture, forestry, and fishing; mining; and gas and electricity and public utilities sectors. The stage-of-processing structure of PPI organizes products by class of buyer and degree of fabrication (that is, finished goods, intermediate goods, and crude materials). The traditional commodity structure of PPI organizes products by similarity of end use or material composition. The industry and product structure of PPI organizes data in accordance with the Standard Industrial Classification (sic) and the product code extension of the sic developed by the U.S. Bureau of the Census.

To the extent possible, prices used in calculating Producer Price Indexes apply to the first significant commercial transaction in the United States from the production or central marketing point. Price data are generally collected monthly, primarily by mail questionnaire. Most prices are obtained directly from producing companies on a voluntary and confidential basis. Prices generally are reported for the Tuesday of the week containing the 13th day of the month.

Since January 1992, price changes for the various commodities have been averaged together with implicit quantity weights representing their importance in the total net selling value of all commodities as of 1987. The detailed data are aggregated to obtain indexes for stage-of-processing groupings, commodity groupings, durability-of-product groupings, and a number of special composite groups. All Producer Price Index data are subject to revision 4 months after original publication.

FOR ADDITIONAL INFORMATION on producer prices, contact the Division of Industrial Prices and Price Indexes: (202) 691-7705.

International Price Indexes

Description of the series

The International Price Program produces monthly and quarterly export and import price indexes for nonmilitary goods traded between the United States and the rest of the world. The export price index provides a measure of price change for all products sold by U.S. residents to foreign buyers. ("Residents" is defined as in the national income accounts; it includes corporations, businesses, and individuals, but does not require the organizations to be U.S. owned nor the individuals to have U.S. citizenship.) The import price index provides a measure of price change for goods purchased from other countries by U.S. residents.

The product universe for both the import and export indexes includes raw materials, agricultural products, semifinished manufactures, and finished manufactures, including both capital and consumer goods. Price data for these items are collected primarily by mail questionnaire. In nearly all cases, the data are collected directly from the exporter or importer, although in a few cases, prices are obtained from other sources.

To the extent possible, the data gathered refer to prices at the U.S. border for exports and at either the foreign border or the U.S. border for imports. For nearly all products, the prices refer to transactions

completed during the first week of the month. Survey respondents are asked to indicate all discounts, allowances, and rebates applicable to the reported prices, so that the price used in the calculation of the indexes is the actual price for which the product was bought or sold.

In addition to general indexes of prices for U.S. exports and imports, indexes are also published for detailed product categories of exports and imports. These categories are defined according to the five-digit level of detail for the Bureau of Economic Analysis End-use Classification (SITE), and the four-digit level of detail for the Harmonized System. Aggregate import indexes by country or region of origin are also available.

BLS publishes indexes for selected categories of internationally traded services, calculated on an international basis and on a balance-of-payments basis.

Notes on the data

The export and import price indexes are weighted indexes of the Laspeyres type. Price relatives are assigned equal importance within each harmonized group and are then aggregated to the higher level. The values assigned to each weight category are based on trade value figures compiled by the Bureau of the Census. The trade weights currently used to compute both indexes relate to 1990.

Because a price index depends on the same items being priced from period to period, it is necessary to recognize when a product's specifications or terms of transaction have been modified. For this reason, the Bureau's questionnaire requests detailed descriptions of the physical and functional characteristics of the products being priced, as well as information on the number of units bought or sold, discounts, credit terms, packaging, class of buyer or seller, and so forth. When there are changes in either the specifications or terms of transaction of a product, the dollar value of each change is deleted from the total price change to obtain the "pure" change. Once this value is determined, a linking procedure is employed which allows for the continued repricing of the item.

For the export price indexes, the preferred pricing is f.a.s. (free alongside ship) U.S. port of exportation. When firms report export prices f.o.b. (free on board), production point information is collected which enables the Bureau to calculate a shipment cost to the port of exportation. An attempt is made to collect two prices for imports. The first is the import price f.o.b, at the foreign port of exportation, which is consistent with the basis for valuation of imports in the national accounts. The second is the import price c.i.f.(costs, insurance, and freight) at the U.S. port of importation, which also includes the other costs associated with bringing the product to the U.S. border. It does not, however, include duty charges. For a given product, only one price basis series is used in the construction of an index.

FOR ADDITIONAL INFORMATION on international prices, contact the Division of International Prices: (202) 691-7155.

Productivity Data

(Tables 2; 39-42)

Business sector and major sectors

Description of the series

The productivity measures relate real output to real input. As such, they encompass a family of measures which include single-factor input measures, such as output per hour, output per unit of labor input, or output per unit of capital input, as well as measures of multifactor productivity (output per unit of combined labor and capital inputs). The Bureau indexes show the change in output relative to changes in the various inputs. The measures cover the business, nonfarm business, manufacturing, and nonfinancial corporate sectors.

Corresponding indexes of hourly compensation, unit labor costs, unit nonlabor payments, and prices are also provided.

Definitions

Output per hour of all persons (labor productivity) is the quantity

of goods and services produced per hour of labor input. Output per unit of capital services (capital productivity) is the quantity of goods and services produced per unit of capital services input. Multifactor productivity is the quantity of goods and services produced per combined inputs. For private business and private nonfarm business, inputs include labor and capital units. For manufacturing, inputs include labor, capital, energy, non-energy materials, and purchased business services.

Compensation per hour is total compensation divided by hours at work. Total compensation equals the wages and salaries of employees plus employers' contributions for social insurance and private benefit plans, plus an estimate of these payments for the self-employed (except for nonfinancial corporations in which there are no self-employed). Real compensation per hour is compensation per hour deflated by the change in the Consumer Price Index for All Urban Consumers.

Unit labor costs are the labor compensation costs expended in the production of a unit of output and are derived by dividing compensation by output. Unit nonlabor payments include profits, depreciation, interest, and indirect taxes per unit of output. They are computed by subtracting compensation of all persons from current-dollar value of output and dividing by output.

Unit nonlabor costs contain all the components of unit nonlabor payments except unit profits.

Unit profits include corporate profits with inventory valuation and capital consumption adjustments per unit of output.

Hours of all persons are the total hours at work of payroll workers, self-employed persons, and unpaid family workers.

Labor inputs are hours of all persons adjusted for the effects of changes in the education and experience of the labor force.

Capital services are the flow of services from the capital stock used in production. It is developed from measures of the net stock of physical assets--equipment, structures, land, and inventories--weighted by rental prices for each type of asset.

Combined units of labor and capital inputs are derived by combining changes in labor and capital input with weights which represent each component's share of total cost. Combined units of labor, capital, energy, materials, and purchased business services are similarly derived by combining changes in each input with weights that represent each input's share of total costs. The indexes for each input and for combined units are based on changing weights which are averages of the shares in the current and preceding year (the Tomquist index-number formula).

Notes on the data

Business sector output is an annually-weighted index constructed by excluding from real gross domestic product (GDP) the following outputs: general government, nonprofit institutions, paid employees of private households, and the rental value of owner-occupied dwellings. Nonfarm business also excludes farming. Private business and private nonfarm business further exclude government enterprises. The measures are supplied by the U.S. Department of Commerce's Bureau of Economic Analysis. Annual estimates of manufacturing sectoral output are produced by the Bureau of Labor Statistics. Quarterly manufacturing output indexes from the Federal Reserve Board are adjusted to these annual output measures by the BLS. Compensation data are developed from data of the Bureau of Economic Analysis and the Bureau of Labor Statistics. Hours data are developed from data of the Bureau of Labor Statistics.

The productivity and associated cost measures in tables 39-42 describe the relationship between output in real terms and the labor and capital inputs involved in its production. They show the changes from period to period in the amount of goods and services produced per unit of input.

Although these measures relate output to hours and capital services, they do not measure the contributions of labor, capital, or any other specific factor of production. Rather, they reflect the joint effect of

many influences, including changes in technology; shifts in the composition of the labor force; capital investment; level of output; changes in the utilization of capacity, energy, material, and research and development; the organization of production; managerial skill; and characteristics and efforts of the work force.

FOR ADDITIONAL INFORMATION on this productivity series, contact the Division of Productivity Research: (202) 691-5606.

Industry productivity measures

Description of the series

The BLS industry productivity data supplement the measures for the business economy and major sectors with annual measures of labor productivity for selected industries at the three- and four-digit levels of the Standard Industrial Classification system. The industry measures differ in methodology and data sources from the productivity measures for the major sectors because the industry measures are developed independently of the National Income and Product Accounts framework used for the major sector measures.

Definitions

Output per hour is derived by dividing an index of industry output by an index of labor input. For most industries, output indexes are derived from data on the value of industry output adjusted for price change. For the remaining industries, output indexes are derived from data on the physical quantity of production.

The labor input series consist of the hours of all employees (production and nonproduction workers), the hours of all persons (paid employees, partners, proprietors, and unpaid family workers), or the number of employees, depending upon the industry.

Notes on the data

The industry measures are compiled from data produced by the Bureau of Labor Statistics, the Departments of Commerce, Interior, and Agriculture, the Federal Reserve Board, regulatory agencies, trade associations, and other sources.

For most industries, the productivity indexes refer to the output per hour of all employees. For some transportation industries, only indexes of output per employee are prepared. For some trade and service industries, indexes of output per hour of all persons (including self-employed) are constructed.

FOR ADDITIONAL INFORMATION on this series, contact the Division of Industry Productivity Studies: (202) 691-5618.

International Comparisons

(Tables 43-45)

Labor force and unemployment

Description of the series

Tables 43 and 44 present comparative measures of the labor force, employment, and unemployment--approximating U.S. concepts--for the United States, Canada, Australia, Japan, and several European countries. The unemployment statistics (and, to a lesser extent, employment statistics) published by other industrial countries are not, in most cases, comparable to U.S. unemployment statistics. Therefore, the Bureau adjusts the figures for selected countries, where necessary, for all known major definitional differences. Although precise comparability may not be achieved, these adjusted figures provide a better basis for international comparisons than the figures regularly published by each country.

Definitions

For the principal U.S. definitions of the labor force, employment, and unemployment, see the Notes section on Employment and Unemployment Data: Household survey data.

Notes on the data

The adjusted statistics have been adapted to the age at which compulsory schooling ends in each country, rather than to the U.S. standard of 16 years of age and older. Therefore, the adjusted statistics relate to the population aged 16 and older in France, Sweden, and the United Kingdom;

15 and older in Canada, Australia, Japan, Germany, Italy from 1993 onward, and the Netherlands; and 14 and older in Italy prior to 1993. The institutional population is included in the denominator of the labor force participation rates and employment-population ratios for Japan and Germany; it is excluded for the United States and the other countries.

In the U.S. labor force survey, persons on layoff who are awaiting recall to their jobs are classified as unemployed. European and Japanese layoff practices are quite different in nature from those in the United States; therefore, strict application of the U.S. definition has not been made on this point. For further information, see Monthly Labor Review, December 1981, pp. 8-11.

The figures for one or more recent years for France, Germany, Italy, the Netherlands, and the United Kingdom are calculated using adjustment factors based on labor force surveys for earlier years and are considered preliminary. The recent-year measures for these countries, therefore, are subject to revision whenever data from more current labor force surveys become available.

There are breaks in the data series for the United States (1990, 1994, 1997, 1998), France (1992), Italy (1991, 1993), the Netherlands (1988), and Sweden (1987).

For the United States, the break in series reflects a major redesign of the labor force survey questionnaire and collection methodology introduced in January 1994. Revised population estimates based on the 1990 census, adjusted for the estimated undercount, also were incorporated. In 1996, previously published data for the 1990-93 period were revised to reflect the 1990 census-based population controls, adjusted for the undercount. In 1997, revised population controls were introduced into the household survey. Therefore, the data are not strictly comparable with prior years. In 1998, new composite estimation procedures and minor revisions in population controls were introduced into the household survey. Therefore, the data are not strictly comparable with data for 1997 and earlier years. See the Notes section on Employment and Unemployment Data of this Review.

For France, the 1992 break reflects the substitution of standardized European Union Statistical Office (EUROSTAT) unemployment statistics for the unemployment data estimated according to the International Labor Office (ILO) definition and published in the Organization for Economic Cooperation and Development (OECD) annual yearbook and quarterly update. This change was made because the EUROSTAT data are more up-to-date than the OECD figures. Also, since 1992, the EUROSTAT definitions are closer to the U.S. definitions than they were in prior years. The impact of this revision was to lower the unemployment rate by 0.1 percentage point in 1992 and 1993, by 0.4 percentage point in 1994, and 0.5 percentage point in 1995.

For Italy, the 1991 break reflects a revision in the method of weighting sample data. The impact was to increase the unemployment rate by approximately 0.3 percentage point, from 6.6 to 6.9 percent in 1991.

In October 1992, the survey methodology was revised and the definition of unemployment was changed to include only those who were actively looking for a job within the 30 days preceding the survey and who were available for work. In addition, the lower age limit for the labor force was raised from 14 to 15 years. (Prior to these changes, BLS adjusted Italy's published unemployment rate downward by excluding from the unemployed those persons who had not actively sought work in the past 30 days.) The break in the series also reflects the incorporation of the 1991 population census results. The impact of these changes was to raise Italy's adjusted unemployment rate by approximately 1.2 percentage points, from 8.3 to 9.5 percent in fourth-quarter 1992. These changes did not affect employment significantly, except in 1993. Estimates by the Italian Statistical Office indicate that employment declined by about 3 percent in 1993, rather than the nearly 4 percent indicated by the data shown in table 44. This difference is attributable mainly to the incorporation of the 1991 population benchmarks in the 1993 data. Data for earlier years have not

been adjusted to incorporate the 1991 census results.

For the Netherlands, a new survey questionnaire was introduced in 1992 that allowed for a closer application of ILO guidelines. EUROSTAT has revised the Dutch series back to 1988 based on the 1992 changes. The 1988 revised unemployment rate is 7.6 percent; the previous estimate for the same year was 9.3 percent.

There have been two breaks in series in the Swedish labor force survey, in 1987 and 1993. Adjustments have been made for the 1993 break back to 1987. In 1987, a new questionnaire was introduced. Questions regarding current availability were added and the period of active workseeking was reduced from 60 days to 4 weeks. These changes lowered Sweden's 1987 unemployment rate by 0.4 percentage point, from 2.3 to 1.9 percent. In 1993, the measurement period for the labor force survey was changed to represent all 52 weeks of the year rather than one week each month and a new adjustment for population totals was introduced. The impact was to raise the unemployment rate by approximately 0.5 percentage point, from 7.6 to 8.1 percent. Statistics Sweden revised its labor force survey data for 1987-92 to take into account the break in 1993. The adjustment raised the Swedish unemployment rate by 0.2 percentage point in 1987 and gradually rose to 0.5 percentage point in 1992.

Beginning with 1987, BLS has adjusted the Swedish data to classify students who also sought work as unemployed. The impact of this change was to increase the adjusted unemployment rate by 0.1 percentage point in 1987 and by 1.8 percentage points in 1994, when unemployment was higher. In 1998, the adjusted unemployment rate had risen from 6.5 to 8.4 percent due to the adjustment to include students.

The net effect of the 1987 and 1993 changes and the BLS adjustment for students seeking work lowered Sweden's 1987 unemployment rate from 2.3 to 2.2 percent.

FOR ADDITIONAL INFORMATION on this series, contact the Division of Foreign Labor Statistics: (202) 691-5654.

Manufacturing productivity and labor costs

Description of the series

Table 45 presents comparative indexes of manufacturing labor productivity (output per hour), output, total hours, compensation per hour, and unit labor costs for the United States, Canada, Japan, and nine European countries. These measures are trend comparisons--that is, series that measure changes over time--rather than level comparisons. There are greater technical problems in comparing the levels of manufacturing output among countries.

BLS constructs the comparative indexes from three basic aggregate measures--output, total labor hours, and total compensation. The hours and compensation measures refer to all employed persons (wage and salary. earners plus self-employed persons and unpaid family workers) in the United States, Canada, Japan, France, Germany, Norway, and Sweden, and to all employees (wage and salary earners) in the other countries.

Definitions

Output, in general, refers to value added in manufacturing from the national accounts of each country. However, the output series for Japan prior to 1970 is an index of industrial production, and the national accounts measures for the United Kingdom are essentially identical to their indexes of industrial production.

The 1977-97 output data for the United States are the gross product originating (value added) measures prepared by the Bureau of Economic Analysis of the U.S. Department of Commerce. Comparable manufacturing output data currently are not available prior to 1977.

U.S. gross product originating is a chain-type annual-weighted series. (For more information on the U.S. measure, see Robert E. Yuskavage, "Improved Estimates of Gross Product by Industry, 1959-94," Survey of Current Business, August 1996, pp. 133-55.) The Japanese value added series is based upon one set of fixed price weights for the years 1970 through 1997. Output series for the other foreign economies also employ fixed price

weights, but the weights are updated periodically (for example, every 5 or 10 years).

To preserve the comparability of the U.S. measures with those for other economies, BLS uses gross product originating in manufacturing for the United States for these comparative measures. The gross product originating series differs from the manufacturing output series that BLS publishes in its news releases on quarterly measures of U.S. productivity and costs (and that underlies the measures that appear in tables 39 and 41 in this section). The quarterly measures are on a "sectoral output" basis, rather than a value-added basis. Sectoral output is gross output less intrasector transactions.

Total labor hours refers to hours worked in all countries. The measures are developed from statistics of manufacturing employment and average hours. The series used for France (from 1970 forward), Norway, and Sweden are official series published with the national accounts. Where official total hours series are not available, the measures are developed by BLS using employment figures published with the national accounts, or other comprehensive employment series, and estimates of annual hours worked. For Germany, BLS uses estimates of average hours worked developed by a research institute connected to the Ministry of Labor for use with the national accounts employment figures. For the other countries, BLS constructs its own estimates of average hours.

Denmark has not published estimates of average hours for 1994--97; therefore, the BLS measure of labor input for Denmark ends in 1993.

Total compensation (labor cost) includes all payments in cash or in-kind made directly to employees plus employer expenditures for legally required insurance programs and contractual and private benefit plans. The measures are from the national accounts of each country, except those for Belgium, which are developed by BLS using statistics on employment, average hours, and hourly compensation. For Canada, France, and Sweden, compensation is increased to account for other significant taxes on payroll or employment. For the United Kingdom, compensation is reduced between 1967 and 1991 to account for employment-related subsidies. Self-employed workers are included in the all-employed-persons measures by assuming that their hourly compensation is equal to the average for wage and salary employees.

Notes on the data

In general, the measures relate to total manufacturing as defined by the International Standard Industrial Classification. However, the measures for France (for all years) and Italy (beginning 1970) refer to mining and manufacturing less energy-related products, and the measures for Denmark include mining and exclude manufacturing handicrafts from 1960 to 1966.

The measures for recent years may be based on current indicators of manufacturing output (such as industrial production indexes), employment, average hours, and hourly compensation until national accounts and other statistics used for the long-term measures become available.

FOR ADDITIONAL INFORMATION on this series, contact the Division of Foreign Labor Statistics: (202) 691-5654.

Occupational Injury and Illness Data

(Tables 46-47)

Survey of Occupational Injuries and Illnesses

Description of the series

The Survey of Occupational Injuries and Illnesses collects data from employers about their workers' job-related nonfatal injuries and illnesses. The information that employers provide is based on records that they maintain under the Occupational Safety and Health Act of 1970. Self-employed individuals, farms with fewer than 11 employees, employers regulated by other Federal safety and health laws, and Federal, State, and local government agencies are excluded from the survey.

The survey is a Federal-State cooperative program with an independent sample selected for each participating State. A stratified random sample with a Neyman allocation is selected to represent all private industries in the State. The survey is stratified by Standard Industrial

Classification and size of employment.

Definitions

Under the Occupational Safety and Health Act, employers maintain records of nonfatal work-related injuries and illnesses that involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment other than first aid.

Occupational injury is any injury such as a cut, fracture, sprain, or amputation that results from a work-related event or a single, instantaneous exposure in the work environment.

Occupational illness is an abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to factors associated with employment. It includes acute and chronic illnesses or disease which may be caused by inhalation, absorption, ingestion, or direct contact.

Lost workday injuries and illnesses are cases that involve days away from work, or days of restricted work activity, or both.

Lost workdays include the number of workdays (consecutive or not) on which the employee was either away from work or at work in some restricted capacity, or both, because of an occupational injury or illness. BLS measures of the number and incidence rate of lost workdays were discontinued beginning with the 1993 survey. The number of days away from work or days of restricted work activity does not include the day of injury or onset of illness or any days on which the employee would not have worked, such as a Federal holiday, even though able to work.

Incidence rates are computed as the number of injuries and/or illnesses or lost work days per 100 full-time workers.

Notes on the data

The definitions of occupational injuries and illnesses are from Recordkeeping Guidelines for Occupational Injuries and Illnesses (U.S. Department of Labor, Bureau of Labor Statistics, September 1986).

Estimates are made for industries and employment size classes for total recordable cases, lost workday cases, days away from work cases, and nonfatal cases without lost workdays. These data also are shown separately for injuries. Illness data are available for seven categories: occupational skin diseases or disorders, dust diseases of the lungs, respiratory conditions due to toxic agents, poisoning (systemic effects of toxic agents), disorders due to physical agents (other than toxic materials), disorders associated with repeated trauma, and all other occupational illnesses.

The survey continues to measure the number of new work-related illness cases which are recognized, diagnosed, and reported during the year. Some conditions, for example, long-term latent illnesses caused by exposure to carcinogens, often are difficult to relate to the workplace and are not adequately recognized and reported. These long-term latent illnesses are believed to be understated in the survey's illness measure. In contrast, the overwhelming majority of the reported new illnesses are those which are easier to directly relate to workplace activity (for example, contact dermatitis and carpal tunnel syndrome).

Most of the estimates are in the form of incidence rates, defined as the number of injuries and illnesses per 100 equivalent full-time workers. For this purpose, 200,000 employee hours represent 100 employee years (2,000 hours per employee). Full detail on the available measures is presented in the annual bulletin, Occupational Injuries and Illnesses: Counts, Rates, and Characteristics.

Comparable data for more than 40 States and territories are available from the BLS Office of Safety, Health and Working Conditions. Many of these States publish data on State and local government employees in addition to private industry data.

Mining and railroad data are furnished to BLS by the Mine Safety and Health Administration and the Federal Railroad Administration. Data from these organizations are included in both the national and State data published annually.

With the 1992 survey, BLS began publishing details on serious, nonfatal incidents resulting in days away from work. Included are some major characteristics of the injured and ill workers, such as occupation, age, gender, race, and length of service, as well as the circumstances of their injuries and illnesses (nature of the disabling condition, part of body affected, event and exposure, and the source directly producing the condition). In general, these data are available nationwide for detailed industries and for individual States at more aggregated industry levels.

FOR ADDITIONAL INFORMATION on occupational injuries and illnesses, contact the Office of Occupational Safety, Health and Working Conditions at (202) 691-6180, or access the Internet at: http://www.bls.gov/oshhome.htm

Census of Fatal Occupational Injuries

The Census of Fatal Occupational Injuries compiles a complete roster of fatal job-related injuries, including detailed data about the fatally injured workers and the fatal events. The program collects and cross checks fatality information from multiple sources, including death certificaFederal workers' compensation reports, Occupational Safety and Health Administration and Mine Safety and Health Administration records, medical examiner and autopsy reports, media accounts, State motor vehicle fatality records, and follow-up questionnaires to employers.

In addition to private wage and salary workers, the self-employed, family members, and Federal, State, and local government workers are covered by the program. To be included in the fatality census, the decedent must have been employed (that is working for pay, compensation, or profit) at the time of the event, engaged in a legal work activity, or present at the site of the incident as a requirement of his or her job.

Definition

A fatal work injury is any intentional or unintentional wound or damage to the body resulting in death from acute exposure to energy, such as heat or electricity, or kinetic energy from a crash, or from the absence of such essentials as heat or oxygen caused by a specific event or incident or series of events within a single workday or shift. Fatalities that occur during a person's commute to or from work are excluded from the census, as well as work related illnesses, which can be difficult to identify due to long latency periods.

Notes on the data

Twenty-eight data elements are collected, coded, and tabulated in the fatality program, including information about the fatally injured worker, the fatal incident, and the machinery or equipment involved. Summary worker demographic data and event characteristics are included in a national news release that is available about 8 months after the end of the reference year. The Census of Fatal Occupational Injuries was initiated in 1992 as a joint Federal-State effort. Most States issue summary information at the time of the national news release.

FOR ADDITIONAL INFORMATION on the Census of Fatal Occupational Injuries contact the BLS Office of Safety, Health, and Working Conditions at (202) 691-6175, or the Internet at:

http://www.bls.gov/oshhome.htm

1. Labor market Indicators

Selected Indicators	1998	1999	1998 II	1998 III
Employment data				
Employment status of the civilian noninstitutionalized population (household survey):(1)				
Labor force participation rate	67.1	67.1	67.0	67.0

Employment-population ratio	64.1	64.3	64.1	64.0
Unemployment rate	4.5	4.2	4.4	4.5
Men	4.4	4.1	4.3	4.5
16 to 24 years	11.1	10.3	10.7	11.5
25 years and over	3.2	3.0	3.1	3.2
Women	4.6	4.3	4.6	4.5
16 to 24 years	98.0	9.5	9.7	9.9
25 years and over	3.6	3.3	3.6	3.5
Employment, nonfarm (payroll data), in thousands:(1)				
Total	125,865	128,786	125,486	126,180
Private sector	106,042	108,616	105,726	106,321
Goods-producing	25,414	25,482	25,427	25,408
Manufacturing	18,805	18,543	18,871	18,765
Service-producing	100,451	103,304	100,059	100,772
Average hours:				
Private sector	34.6	34.5	34.6	34.6
Manufacturing	41.7	41.7	41.7	41.7
Overtime	4.6	4.6	4.6	4.6
Employment Cost Index(2)				
Percent change in the ECI, compensation:				
All workers (excluding farm, household and Federal workers)	3.4	3.4	.8	1.2
Private industry workers	3.5	3.4	.9	1.1
Goods-producing(3)	2.8	3.4	.8	.7
Service-producing(3)	3.6	3.4	.8	1.3
State and local government workers	3.0	3.4	.3	1.5
Workers by bargaining status (private industry):				
Union	3.0	2.7	1.0	1.1
Nonunion	3.5	3.6	.8	1.1

	1998	1999		
Selected Indicators	IV	I	II	III
Employment data				
Employment status of the civilian noninstitutionalized population (household survey):(1)				
Labor force participation rate	67.1	67.2	67.1	67.0

Employment-population	64.1	64.3	64.2	64.2
ratio	4.4	4.3	4.3	4.2
Unemployment rate	4.3	4.2	4.2	4.1
Men	10.6	10.4	10.4	10.0
16 to 24 years	3.1	30.0	3.0	3.0
25 years and over	4.6	44.0	4.4	4.4
Women	9.4	9.8	9.2	9.5
16 to 24 years	3.6	3.4	3.4	3.3
25 years and over				
Employment, nonfarm (payroll data),				
in thousands:(1)	26,967	127,800	126,430	129,073
Total	7,016	107,741	106,319	108,874
Private sector	25,489	25,488	25,454	25,459
Goods-producing	18,716	18,632	18,543	18,516
Manufacturing	1,498	102,312	102,976	103,614
Service-producing				
Average hours:	34.6	34.5	34.5	34.5
Private sector	41.7	415.0	41.7	41.8
Manufacturing	4.5	4.5	4.6	4.6
Overtime				
Employment Cost Index(2)				
Percent change in the ECI, compensation:				
All workers (excluding farm, household and Federal workers)	.6	.4	1.0	1.1
Private industry workers	.6	.4	1.1	.9
Goods-producing(3)	.5	.8	.7	.9
Service-producing(3)	.6	.3	1.3	.9
State and local government workers	.6	.5	.4	1.5
Workers by bargaining status				
(private industry):	.5	.4	.7	.9
Union	.6	.5	1.2	.9
Nonunion				

	1999	2000	
Selected Indicators	IV	I	II
Employment data			
Employment status of the civilian noninstitutionalized population (household survey):(1)			
Labor force	67.0	67.5	67.3
participation rate			

Employment-population	64.3	64.7	64.6
ratio	4.1	4.1	4.0
Unemployment rate	4.0	4.0	3.9
Men	10.4	9.7	9.7
16 to 24 years	2.9	2.9	2.8
25 years and over	4.2	4.2	4.1
Women	9.4	9.6	9.0
16 to 24 years	3.1	3.2	3.2
25 years and over			
Employment, nonfarm (payroll data),			
in thousands:(1)	129,783	130,626	131,552
Total	109,507	110,195	110,725
Private sector	25,524	25,680	25,703
Goods-producing	18,482	18,481	18,488
Manufacturing	104,259	104,946	105,849
Service-producing			
Average hours:	34.5	34.5	34.5
Private sector	41.7	41.7	41.7
Manufacturing	4.7	4.6	4.7
Overtime			
Employment Cost Index(2)			
Percent change in the ECI, compensation:			
All workers (excluding farm, household and Federal workers)	.9	1.3	10.0
Private industry workers	.9	1.5	1.2
Goods-producing(3)	1.0	1.6	1.2
Service-producing(3)	.8	1.4	1.2
State and local government workers	1.0	.6	.3
Workers by bargaining status			
(private industry):	.7	1.5	10.0
Union	1.0	1.3	1.2
Nonunion			

(1) Quarterly data seasonally adjusted.

(2) Annual changes are December-to-December changes. Quarterly changes are calculated using the last month of each quarter.

(3) Goods-producing industries include mining, construction, and manufacturing. Service-producing industries include all other private sector industries.

2. Annual and quarterly percent changes in compensation, prices, and productivity

			1998		
Selected measures	1998	1999	II	III	IV
Compensation data(1,2)					

Employment Cost Index--compensation (wages, salaries, benefits):					
Civilian nonfarm	3.4	3.4	0.8	1.2	0.6
Private nonfarm	3.5	3.4	.9	1.1	.6
Employment Cost Index--wages and salaries:					
Civilian nonfarm	3.7	3.5	.7	1.3	.7
Private nonfarm	3.9	3.5	.9	1.3	.6
Price data(1)					
Consumer Price index (All Urban Consumers):					
All Items	1.6	2.7	.5	.4	.2
Producer Price Index:					
Finished goods	.0	2.9	.5	-.1	.4
Finished consumer goods	.0	3.8	.8	.0	.2
Capital equipment	.0	.3	-.5	-.4	.9
Intermediate materials, supplies, and components	-3.3	3.7	.2	-.5	-1.6
Crude materials	-16.7	15.3	-1.8	-5.6	-2.5
Productivity data(3)					
Output per hour of all persons:					
Business sector	2.7	3.1	1.1	2.1	3.9
Nonfarm business sector	2.6	2.9	1.6	1.8	3.6
Nonfinancial corporations(4)	3.6	4.3	4.0	5.2	3.4

	1999			
Selected measures	I	II	III	IV
Compensation data(1,2)				
Employment Cost Index--compensation (wages, salaries, benefits):				
Civilian nonfarm	0.4	1.0	1.1	0.9
Private nonfarm	.4	1.1	.9	.9
Employment Cost Index--wages and salaries:				
Civilian nonfarm	.5	1.0	1.1	.8
Private nonfarm	.5	1.2	.9	.9
Price data(1)				
Consumer Price index (All Urban Consumers):				
All Items	.7	.7	1.0	.2
Producer Price Index:				
Finished goods	.0	1.2	1.5	.1
Finished consumer goods	.0	1.8	2.2	-.2

Capital equipment	-.1	-.4	-.4	1.2
Intermediate materials, supplies, and components	-.2	1.9	1.9	.1
Crude materials	-.1	9.4	10.2	-3.5
Productivity data(3)				
Output per hour of all persons:				
Business sector	3.3	.9	4.9	7.7
Nonfarm business sector	2.6	.6	5.2	8.0
Nonfinancial corporations(4)	4.4	3.8	5.1	6.1

	2000	
Selected measures	I	II
Compensation data(1,2)		
Employment Cost Index--compensation (wages, salaries, benefits):		
Civilian nonfarm	1.3	1.0
Private nonfarm	1.5	1.2
Employment Cost Index--wages and salaries:		
Civilian nonfarm	1.1	1.0
Private nonfarm	1.2	1.0
Price data(1)		
Consumer Price index (All Urban Consumers):		
All Items	1.7	.7
Producer Price Index:		
Finished goods	1.4	1.2
Finished consumer goods	1.8	1.5
Capital equipment	.1	.0
Intermediate materials, supplies, and components	1.9	1.5
Crude materials	9.1	7.8
Productivity data(3)		
Output per hour of all persons:		
Business sector	1.6	6.5
Nonfarm business sector	1.9	5.7
Nonfinancial corporations(4)	2.9	5.0

(1) Annual changes are December-to-December changes. Quarterly changes are calculated using the last month of each quarter. Compensation and price data are not seasonally adjusted, and the price data are not compounded.

(2) Excludes Federal and private household workers.

(3) Annual rates of change are computed by comparing annual averages. Quarterly percent changes reflect annual rates of change in quarterly indexes. The data are seasonally adjusted.

(4) Output per hour of all employees.

3. Alternative measures of wage and compensation changes

Components	Quarterly average 1999 I	II	III	IV
Average hourly compensation:(1)				
All persons, business sector	5.2	5.0	5.3	3.8
All persons, nonfarm business sector	4.5	5.0	5.5	4.2
Employment Cost Index--compensation:				
Civilian nonfarm(2)	.4	1.0	1.1	.9
Private nonfarm	.4	1.1	.9	.9
Union	.4	.7	.9	.7
Nonunion	.5	1.2	.9	1.0
State and local governments	.5	.4	1.5	1.0
Employment Cost Index--wages and salaries:				
Civilian nonfarm(2)	.5	1.0	1.1	.8
Private nonfarm	.5	1.2	.9	.9
Union	.4	.8	.7	.6
Nonunion	.5	1.2	.9	.9
State and local governments	.4	.4	1.9	.9

Components	Quarterly average 2000 I	II	Four quarters ending-- 1999 I	II
Average hourly compensation:(1)				
All persons, business sector	5.1	6.4	5.1	5.0
All persons, nonfarm business sector	4.9	5.3	4.9	4.8
Employment Cost Index--compensation:				
Civilian nonfarm(2)	3.0	1.0	3.0	3.2
Private nonfarm	3.0	1.2	3.0	3.3
Union	3.0	1.0	3.0	2.7
Nonunion	3.0	1.2	3.0	3.4
State and local governments	2.9	.3	2.9	3.0
Employment Cost Index--wages and salaries:				
Civilian nonfarm(2)	3.3	1.0	3.3	3.6
Private nonfarm	3.3	1.0	3.3	3.6
Union	3.1	.9	3.1	3.1
Nonunion	3.3	1.1	3.3	3.7

State and local governments	2.9	.3	2.9	3.1

Components	Four quarters ending-- 1999 III	IV	2000 I	II
Average hourly compensation:(1)				
All persons, business sector	5.1	4.8	4.4	4.7
All persons, nonfarm business sector	4.8	4.8	4.6	4.7
Employment Cost Index--compensation:				
Civilian nonfarm(2)	3.1	3.4	4.3	4.4
Private nonfarm	3.1	3.4	4.6	4.6
Union	2.5	2.7	3.6	3.9
Nonunion	3.2	3.6	4.7	4.6
State and local governments	2.9	3.4	3.6	3.5
Employment Cost Index--wages and salaries:				
Civilian nonfarm(2)	3.3	3.5	4.0	4.0
Private nonfarm	3.2	3.5	4.2	4.1
Union	2.5	2.6	2.7	2.8
Nonunion	3.3	3.6	4.4	4.3
State and local governments	3.3	3.6	3.8	3.7

(1) Seasonally adjusted. "Quarterly average" is percent change from a quarter ago, at an annual rate.

(2) Excludes Federal and household workers.

4. Employment status of the population, by sex, age, race, and Hispanic origin, monthly data seasonally adjusted

(Numbers in thousands)

Employment status	Annual average 1998	1999	1999 Aug.
TOTAL			
Civilian noninstitutional population(1)	205,220	207,753	208,038
Civilian labor force	137,673	139,368	139,372
Participation rate	67.1	67.1	67.0
Employed	131,463	133,468	133,530
Employment-population ratio(2)	64.1	64.3	64.2
Unemployed	6,210	5,880	5,842
Unemployment rate	4.5	4.2	4.2
Not in the labor force	67,547	68,385	68,666
Men, 20 years and over			
Civilian noninstitutional population(1)	93,790	91,555	91,692
Civilian labor force	69,715	70,194	70,240
Participation rate	76.8	76.7	76.6
Employed	67,135	67,761	67,768

Employment-pop-			
ulation ratio(2)	73.9	74.0	73.9
Agriculture	2,350	2,244	2,237
Nonagricultural			
industries	64,785	65,517	65,531
Unemployed	2,580	2,433	2,472
Unemployment rate	3.7	3.5	3.5
Women, 20 years and over			
Civilian noninstitutional			
population(1)	98,768	100,158	100,285
Civilian labor force	59,702	60,840	60,904
Participation rate	60.4	60.7	60.7
Employed	57,278	58,555	58,648
Employment-pop-			
ulation ratio(2)	58.0	58.5	58.5
Agriculture	768	803	780
Nonagricultural			
industries	56,510	57,752	57,868
Unemployed	2,424	2,285	2,256
Unemployment rate	4.1	3.8	3.7
Both sexes, 16 to 19 years			
Civilian noninstitutional			
population(1)	15,644	16,040	16,061
Civilian labor force	8,256	8,333	8,228
Participation rate	52.8	52.0	51.2
Employed	7,051	7,172	7,114
Employment-pop-			
ulation ratio(2)	45.1	44.7	44.3
Agriculture	261	234	217
Nonagricultural			
industries	6,790	6,936	6,897
Unemployed	1,205	1,162	1,114
Unemployment rate	14.6	13.9	13.5
White			
Civilian noninstitutional			
population(1)	171,478	173,085	173,275
Civilian labor force	115,415	116,509	116,619
Participation rate	67.3	67.3	67.3
Employed	110,931	112,235	112,308
Employment-pop-			
ulation ratio(2)	64.7	64.8	648.0
Unemployed	4,484	4,273	4,311
Unemployment rate	3.9	3.7	3.7
Black			
Civilian noninstitutional			
population(1)	24,373	24,855	24,904
Civilian labor force	15,982	16,365	16,321
Participation rate	65.6	65.8	65.5
Employed	14,556	15,056	15,047
Employment-pop-			
ulation ratio(2)	59.7	60.6	60.4
Unemployed	1,426	1,309	1,274
Unemployment rate	8.9	8.0	7.8
Hispanic origin			
Civilian noninstitutional			
population(1)	21,070	21,650	21,752

Civilian labor force	14,317	14,665	14,710
Participation rate	67.9	67.7	67.6
Employed	13,291	13,720	13,759
Employment-pop-ulation ratio(2)	63.1	63.4	63.3
Unemployed	1,026	945	951
Unemployment rate	7.2	6.4	6.5

Employment status	1999 Sept.	1999 Oct.	1999 Nov.
TOTAL			
Civilian noninstitutional population(1)	208,265	208,483	208,866
Civilian labor force	139,475	139,697	139,834
Participation rate	67.0	67.0	67.0
Employed	133,650	133,940	134,098
Employment-pop-ulation ratio(2)	64.2	64.2	64.3
Unemployed	5,825	5,757	5,736
Unemployment rate	4.2	4.1	4.1
Not in the labor force	68,790	68,786	68,832
Men, 20 years and over			
Civilian noninstitutional population(1)	91,793	91,896	91,986
Civilian labor force	70,328	70,339	70,388
Participation rate	78.6	76.5	76.5
Employed	67,943	67,898	68,037
Employment-pop-ulation ratio(2)	74.0	73.9	74.0
Agriculture	2,189	2,206	2,262
Nonagricultural industries	65,754	65,692	65,775
Unemployed	2,385	2,441	2,351
Unemployment rate	3.4	3.5	3.3
Women, 20 years and over			
Civilian noninstitutional population(1)	100,385	100,458	100,573
Civilian labor force	60,860	60,955	61,052
Participation rate	60.6	60.7	60.7
Employed	58,630	58,800	58,838
Employment-pop-ulation ratio(2)	58.4	58.5	58.5
Agriculture	778	800	768
Nonagricultural industries	57,852	58,000	58,070
Unemployed	2,230	2,155	2,214
Unemployment rate	3.7	3.5	3.6
Both sexes, 16 to 19 years			
Civilian noninstitutional population(1)	16,086	16,129	16,107
Civilian labor force	8,287	8,403	8,394
Participation rate	51.5	52.1	52.1
Employed	7,077	7,242	7,223
Employment-pop-ulation ratio(2)	44.0	44.9	44.8
Agriculture	212	232	280

Nonagricultural industries	6,865	7,010	6,943
Unemployed	1,210	1,161	1,171
Unemployment rate	14.6	13.8	14.0
White			
Civilian noninstitutional population(1)	173,432	173,585	173,709
Civilian labor force	116,495	116,654	116,703
Participation rate	67.2	67.2	67.2
Employed	112,303	112,548	112,611
Employment-population ratio(2)	54.8	64.8	64.8
Unemployed	4,192	4,106	4,092
Unemployment rate	3.6	3.5	3.5
Black			
Civilian noninstitutional population(1)	24,946	24,985	25,019
Civilian labor force	16,474	16,469	16,508
Participation rate	66.0	66.0	66.0
Employed	15,114	15,124	15,187
Employment-population ratio(2)	60.6	60.5	60.7
Unemployed	1,360	1,365	1,321
Unemployment rate	8.3	8.3	8.0
Hispanic origin			
Civilian noninstitutional population(1)	21,820	21,881	21,947
Civilian labor force	14,766	14,809	14,887
Participation rate	67.7	67.7	67.8
Employed	13,795	13,879	13,979
Employment-population ratio(2)	63.2	63.4	63.7
Unemployed	971	930	908
Unemployment rate	6.6	6.3	6.1

Employment status	1999 Dec.	2000 Jan.	2000 Feb.
TOTAL			
Civilian noninstitutional population(1)	208,832	208,782	208,907
Civilian labor force	140,108	140,910	141,165
Participation rate	67.1	67.5	67.6
Employed	134,420	135,221	135,362
Employment-population ratio(2)	64.4	64.8	64.8
Unemployed	5,688	5,689	5,804
Unemployment rate	4.1	4.0	4.1
Not in the labor force	68,724	67,872	67,742
Men, 20 years and over			
Civilian noninstitutional population(1)	92,052	92,057	92,082
Civilian labor force	70,529	70,917	71,120
Participation rate	76.6	77.0	77.2
Employed	68,197	68,585	68,691

Employment-population ratio(2)	74.1	74.5	74.6
Agriculture	2,227	2,303	2,309
Nonagricultural industries	65,970	66,282	66,382
Unemployed	2,332	2,332	2,429
Unemployment rate	3.3	3.3	3.4
Women, 20 years and over			
Civilian noninstitutional population(1)	100,666	100,579	100,666
Civilian labor force	61,154	61,576	61,575
Participation rate	60.7	61.2	61.2
Employed	58,958	59,280	59,398
Employment-population ratio(2)	58.6	58.9	59.0
Agriculture	791	826	871
Nonagricultural industries	58,167	58,454	58,526
Unemployed	2,196	2,297	2,178
Unemployment rate	3.6	3.7	3.5
Both sexes, 16 to 19 years			
Civilian noninstitutional population(1)	16,114	16,147	16,149
Civilian labor force	8,425	8,416	8,470
Participation rate	52.3	52.1	52.4
Employed	7,265	7,356	7,273
Employment-population ratio(2)	45.1	45.6	45.0
Agriculture	261	242	228
Nonagricultural industries	7,004	7,114	7,046
Unemployed	1,160	1,060	1,197
Unemployment rate	13.8	12.6	14.1
White			
Civilian noninstitutional population(1)	173,821	173,812	173,686
Civilian labor force	117,008	117,716	117,821
Participation rate	67.3	67.7	67.8
Employed	112,951	113,704	113,634
Employment-population ratio(2)	65.0	65.4	65.3
Unemployed	4,057	4,011	4,187
Unemployment rate	3.5	3.4	3.6
Black			
Civilian noninstitutional population(1)	25,051	25,047	25,076
Civilian labor force	16,513	16,622	16,785
Participation rate	65.9	66.4	66.9
Employed	15,204	15,254	15,471
Employment-population ratio(2)	60.7	60.9	61.7
Unemployed	1,309	1,368	1,314
Unemployment rate	7.9	8.2	7.8
Hispanic origin			
Civilian noninstitutional population(1)	22,008	22,047	22,108

Civilian labor force	14,984	15,251	15,249
Participation rate	68.1	69.2	69.0
Employed	14,095	14,395	14,382
Employment-population ratio(2)	64.0	65.3	65.1
Unemployed	889	856	868
Unemployment rate	59.0	5.6	5.7

Employment status	2000 Mar.	2000 Apr.	2000 May
TOTAL			
Civilian noninstitutional population(1)	209,053	209,218	209,371
Civilian labor force	140,867	141,230	140,489
Participation rate	67.4	67.5	67.1
Employed	135,159	135,706	134,715
Employment-population ratio(2)	64.7	64.9	64.3
Unemployed	5,708	5,524	5,774
Unemployment rate	4.1	3.9	4.1
Not in the labor force	68,187	67,986	68,682
Men, 20 years and over			
Civilian noninstitutional population(1)	92,145	92,303	92,408
Civilian labor force	70,822	70,761	70,603
Participation rate	76.9	76.7	76.4
Employed	68,480	68,481	68,230
Employment-population ratio(2)	74.3	74.2	73.8
Agriculture	2,232	2,213	2,217
Nonagricultural industries	68,249	66,269	66,013
Unemployed	2,342	2,280	2,373
Unemployment rate	3.3	3.2	3.4
Women, 20 years and over			
Civilian noninstitutional population(1)	100,713	100,809	100,929
Civilian labor force	61,671	61,920	61,614
Participation rate	612.0	61.4	61.0
Employed	59,422	59,757	59,248
Employment-population ratio(2)	59.0	59.3	58.7
Agriculture	894	899	854
Nonagricultural industries	58,528	58,858	58,383
Unemployed	2,249	2,163	2,367
Unemployment rate	3.6	3.5	3.8
Both sexes, 16 to 19 years			
Civilian noninstitutional population(1)	16,196	16,104	16,034
Civilian labor force	8,374	8,549	8,271
Participation rate	51.7	53.1	51.6
Employed	7,257	7,467	7,237
Employment-population ratio(2)	44.8	46.4	45.1
Agriculture	233	243	217

Nonagricultural industries	7,024	7,224	7,020
Unemployed	1,117	1,082	1,034
Unemployment rate	13.3	12.7	12.5
White			
Civilian noninstitutional population(1)	173,983	174,092	174,197
Civilian labor force	117,832	117,988	117,097
Participation rate	67.7	67.8	67.2
Employed	113,630	113,915	112,988
Employment-pop-ulation ratio(2)	65.3	65.4	64.9
Unemployed	4,202	4,073	4,108
Unemployment rate	3.6	3.5	3.5
Black			
Civilian noninstitutional population(1)	25,105	25,135	25,161
Civilian labor force	16,572	16,636	16,596
Participation rate	66.0	66.2	66.0
Employed	15,356	15,444	15,261
Employme ulation ratio(2)	61.2	614.0	60.7
Unemployed	1,216	1,191	1,335
Unemployment rate	7.3	7.2	8.0
Hispanic origin			
Civilian noninstitutional population(1)	22,166	22,231	22,292
Civilian labor force	15,313	15,355	15,322
Participation rate	69.1	69.1	68.7
Employed	14,355	14,524	14,432
Employment-pop-ulation ratio(2)	64.8	65.3	64.7
Unemployed	958	831	890
Unemployment rate	6.3	5.4	5.8

		2000	
Employment status	June	July	Aug.
TOTAL			
Civilian noninstitutional population(1)	209,543	209,727	209,935
Civilian labor force	140,762	140,399	140,742
Participation rate	67.2	66.9	67.0
Employed	135,179	134,749	134,912
Employment-pop-ulation ratio(2)	64.5	64.2	64.3
Unemployed	5,583	5,650	5,829
Unemployment rate	4.0	4.0	4.1
Not in the labor force	68,781	69,329	69,193
Men, 20 years and over			
Civilian noninstitutional population(1)	92,546	92,642	92,754
Civilian labor force	70,714	70,702	71,067
Participation rate	76.4	76.3	76.6
Employed	68,430	68,440	68,757

Employment-population ratio(2)	739.0	73.9	74.1
Agriculture	2,289	2,296	2,288
Nonagricultural industries	66,161	66,144	66,469
Unemployed	2,264	2,263	2,309
Unemployment rate	3.2	3.2	3.2
Women, 20 years and over			
Civilian noninstitutional population(1)	101,007	101,111	101,209
Civilian labor force	61,596	61,508	61,260
Participation rate	61.0	60.8	60.5
Employed	59,278	59,222	58,949
Employment-population ratio(2)	58.7	58.6	58.2
Agriculture	834	792	824
Nonagricultural industries	58,444	58,430	58,125
Unemployed	2,318	2,288	2,311
Unemployment rate	3.8	3.7	3.8
Both sexes, 16 to 19 years			
Civilian noninstitutional population(1)	15,991	15,974	15,972
Civilian labor force	8,452	8,189	8,415
Participation rate	52.9	51.3	52.7
Employed	7,471	7,087	7,206
Employment-population ratio(2)	46.7	44.4	48.1
Agriculture	218	211	232
Nonagricultural industries	7,253	6,876	6,974
Unemployed	981	1,101	1,209
Unemployment rate	11.6	13.4	14.4
White			
Civilian noninstitutional population(1)	174,316	174,443	174,587
Civilian labor force	117,451	117,258	117,551
Participation rate	67.4	67.2	67.3
Employed	113,484	113,156	113,352
Employment-population ratio(2)	65.1	64.9	64.9
Unemployed	3,967	4,103	4,199
Unemployment rate	3.4	3.5	3.6
Black			
Civilian noninstitutional population(1)	25,191	25,221	25,256
Civilian labor force	16,557	16,456	16,512
Participation rate	65.8	65.2	65.4
Employed	15,275	15,190	15,190
Employment-population ratio(2)	60.6	60.2	60.1
Unemployed	1,302	1,266	1,322
Unemployment rate	7.9	7.7	8.0
Hispanic origin			
Civilian noninstitutional population(1)	22,355	22,422	22,488

Civilian labor force	15,325	15,188	15,248
Participation rate	68.6	67.7	67.8
Employed	14,461	14,339	14,371
Employment-population ratio(2)	64.7	64.0	63.9
Unemployed	864	649	876
Unemployment rate	5.6	5.6	5.7

(1) The population figures are not seasonally adjusted.

(2) Civilian employment as a percent of the civilian noninstitutional population,

NOTE: Detail for the above race and Hispanic origin groups will not sum to totals because data for the "other races" groups are not presented and Hispanics are included in both the white and black population groups.

5. Selected employment indicators, monthly data seasonally adjusted

(In thousands)

Selected categories	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
Characteristic				
Employed, 16 years and over	131,463	133,488	133,650	133,650
Men	70,693	71,446	71,630	71,630
Women	60,771	62,042	62,020	62,020
Married men, spouse present	42,923	43,254	43,368	43,367
Married women, spouse present	32,872	33,450	33,275	33,275
Women who maintain families	7,904	8,229	8,335	8,312
Class of worker				
Agriculture:				
Wage and salary workers	2,000	1,944	1,908	1,930
Self-employed workers	1,341	1,297	1,266	1,198
Unpaid family workers	38	40	46	40
Nonagricultural industries:				
Wage and salary workers	119,019	121,323	121,150	121,583
Government	18,383	18,903	19,114	19,080
Private industries	100,637	102,420	102,036	102,503
Private households	962	933	873	1,035
Other	99,674	101,487	101,163	101,468
Self-employed workers	8,962	8,790	9,000	8,791
Unpaid family workers	103	95		100
Persona at work part time(1)				
All industries:				
Part time for economic reasons	3,665	3,357	3,279	3,283
Slack work or business				

conditions	2,095	1,968	1,904	1,922
Could only find part-time work	1,258	1,079	1,057	1,073
Part time for noneconomic reasons	18,530	18,758	19,230	18,801
Nonagricultural industries:				
Part time for economic reasons	3,501	3,189	3,127	3,112
Slack work or business conditions	1,997	1,861	1,813	1,806
Could only find part-time work	1,228	1,056	1,041	1,063
Part time for noneconomic reasons	17,954	18,197	18,652	18,273

	1999			2000
Selected categories	Oct.	Nov.	Dec.	Jan.
Characteristic				
Employed, 16 years and over	133,940	134,098	134,420	135,221
Men	71,623	71,732	71,927	72,358
Women	62,317	62,366	62,493	62,863
Married men, spouse present	43,206	43,273	43,283	43,951
Married women, spouse present	33,521	33,635	33,762	34,166
Women who maintain families	8,398	8,526	8,375	8,362
Class of worker				
Agriculture:				
Wage and salary workers	1,936	2,049	2,018	2,024
Self-employed workers	1,267	1,216	1,211	1,320
Unpaid family workers	42	41	36	38
Nonagricultural industries:				
Wage and salary workers	12,165	121,965	122,426	122,823
Government	18,817	18,902	18,959	19,013
Private industries	102,837	103,063	103,467	103,810
Private households	939	944	948	952
Other	101,898	102,119	102,519	102,858
Self-employed workers	8,833	8,686	8,662	8,802
Unpaid family workers	101	108	98	92
Persona at work part time(1)				

All industries:				
Part time for economic reasons	3,179	3,274	3,320	3,219
Slack work or business conditions	1,928	1,930	1,951	1,893
Could only find part-time work	993	1,032	1,025	1,012
Part time for noneconomic reasons	18,799	18,651	18,618	18,889
Nonagricultural industries:				
Part time for economic reasons	2,983	3,105	3,157	3,066
Slack work or business conditions	1,807	1,815	1,843	1,801
Could only find part-time work	964	1,013	1,018	966
Part time for noneconomic reasons	18,249	18,083	18,061	18,347

	2000			
Selected categories	Feb.	Mar.	Apr.	May
Characteristic				
Employed, 16 years and over	135,362	135,159	135,706	134,715
Men	72,473	72,313	72,307	71,948
Women	62,889	62,846	63,399	62,767
Married men, spouse present	43,535	43,297	43,272	43,216
Married women, spouse present	33,882	33,780	33,877	33,786
Women who maintain families	8,220	8,082	8,307	8,301
Class of worker				
Agriculture:				
Wage and salary workers	2,025	2,043	2,054	2,006
Self-employed workers	1,344	1,292	1,272	1,252
Unpaid family workers	51	42	43	38
Nonagricultural industries:				
Wage and salary workers	123,166	123,169	123,623	122,860
Government	19,394	19,598	19,280	19,169
Private industries	103,772	103,571	104,343	103,691
Private households	1,016	998	1,019	953
Other	102,756	102,573	103,324	102,783

Self-employed workers	8,793	8,704	8,750	8,714
Unpaid family workers	74	107	103	82
Persona at work part time(1)				
All industries:				
Part time for economic reasons	3,139	3,124	3,124	3,248
Slack work or business conditions	1,807	1,820	1,844	1,962
Could only find part-time work	1,023	953	1,016	978
Part time for noneconomic reasons	19,031	18,770	18,474	18,409
Nonagricultural industries:				
Part time for economic reasons	2,985	3,003	3,021	3,096
Slack work or business conditions	1,705	1,766	1,782	1,840
Could only find part-time work	1,005	922	989	962
Part time for noneconomic reasons	18,406	18,184	17,943	17,853

	2000		
Selected categories	June	July	Aug.
Characteristic			
Employed, 16 years and over	135,179	134,749	134,912
Men	72,217	72,063	72,407
Women	62,962	62,686	62,505
Married men, spouse present	43,357	43,284	43,372
Married women, spouse present	33,824	33,618	33,413
Women who maintain families	8,280	8,483	8,519
Class of worker			
Agriculture:			
Wage and salary workers	2,059	2,079	2,056
Self-employed workers	1,775	1,182	1,258
Unpaid family workers	50	40	37
Nonagricultural			

industries:			
Wage and salary workers	123,002	122,681	122,773
Government	18,777	18,497	18,496
Private industries	104,225	104,184	104,227
Private households	957	807	716
Other	103,268	103,377	103,561
Self-employed workers	8,665	8,609	8,590
Unpaid family workers	71	80	116
Persona at work part time(1)			
All industries:			
Part time for economic reasons	3,117	3,071	3,164
Slack work or business conditions	1,811	1,846	1,997
Could only find part-time work	1,022	900	855
Part time for noneconomic reasons	18,308	18,558	18,709
Nonagricultural industries:			
Part time for economic reasons	2,967	2,940	3,038
Slack work or business conditions	1,713	1,750	1,924
Could only find part-time work	994	881	838
Part time for noneconomic reasons	17,743	18,041	18,190

(1) Excludes persons "with a job but not at work" during the survey period for such reasons as vacation, illness, or industrial disputes.

6. Selected unemployment Indicators, monthly data seasonally adjusted

(Unemployment rates)

Selected categories	Annual average 1998	Annual average 1999	1999 Aug.
Characteristic			
Total, 16 years and over	4.5	4.2	4.2
Both sexes, 16 to 19 years	14.6	13.9	13.5
Men, 20 years and over	3.7	3.5	3.5
Women, 20 years and over	4.1	3.8	3.7
White, total	3.9	3.7	3.7
Both sexes, 16to 19 years	12.6	12.0	11.7

Men, 16to 19 years	14.1	12.6	12.3
Women, 16to 19 years	10.9	11.3	11.0
Men, 20 years and over	3.2	3.0	3.2
Women, 20 years and over	3.4	3.3	3.2
Black, total	8.9	8.0	7.8
Both sexes, 16 to 19 years	27.6	27.9	28.1
Men, 16 to 19 years	30.1	30.9	29.6
Women, 16 to 19 years	25.3	25.1	26.7
Men, 20 years and over	7.4	6.7	6.3
Women, 20 years and over	7.9	6.8	6.9
Hispanic origin, total	7.2	6.4	6.5
Married men, spouse present	2.4	2.2	2.3
Married women, spouse present	2.9	2.7	2.7
Women who maintain families	7.2	6.4	6.3
Full-time workers	4.3	4.1	4.1
Part-time workers	5.3	5.0	4.6
Industry			
Nonagricultural wage and salary workers	4.6	4.3	4.2
Mining	3.2	5.7	4.2
Construction	7.5	7.0	7.6
Manufacturing	3.9	3.6	3.8
Durable goods	3.4	3.5	3.7
Nondurable goods	4.7	3.9	4.1
Transportation and public utilities	3.4	3.0	3.0
Wholesale and retail trade	5.5	5.2	4.8
Finance, insurance, and real estate	2.5	2.3	2.4
Services	4.5	4.1	4.0
Government workers	23.0	2.2	2.1
Agricultural wage and salary workers	8.3	8.9	9.6
Educational attainment(1)			
Less than a high school diploma	7.1	6.7	7.0
High school graduates, no college	4.0	3.5	3.5
Some college, less than a bachelor's degree	3.0	2.8	3.1
College graduates	1.8	1.8	1.6

	1999		
Selected categories	Sept.	Oct.	Nov.
Characteristic			
Total, 16 years and over	4.2	4.1	4.1
Both sexes, 16 to 19 years	14.6	13.8	14.0

Men, 20 years and over	3.4	3.5	3.3
Women, 20 years and over	3.7	3.5	3.6
White, total	3.6	3.5	3.5
Both sexes, 16to 19 years	12.3	11.8	12.0
Men, 16to 19 years	12.7	11.9	12.8
Women, 16to 19 years	11.9	11.7	11.2
Men, 20 years and over	2.9	2.9	2.8
Women, 20 years and over	3.2	3.1	3.1
Black, total	8.3	8.3	8.0
Both sexes, 16 to 19 years	30.8	30.8	28.4
Men, 16 to 19 years	30.3	35.3	31.0
Women, 16 to 19 years	31.4	26.1	25.9
Men, 20 years and over	7.1	7.7	7.0
Women, 20 years and over	6.7	6.1	6.6
Hispanic origin, total	6.6	6.3	6.1
Married men, spouse present	2.2	2.2	2.1
Married women, spouse present	2.6	2.5	2.5
Women who maintain families	6.4	6.0	6.0
Full-time workers	4.0	4.0	3.9
Part-time workers	5.0	4.7	4.9
Industry			
Nonagricultural wage and salary workers	4.3	4.2	4.2
Mining	6.7	5.0	4.6
Construction	6.9	6.7	5.7
Manufacturing	3.9	3.7	3.7
Durable goods	4.0	3.5	3.7
Nondurable goods	3.9	4.0	3.7
Transportation and public utilities	2.8	3.1	3.3
Wholesale and retail trade	5.2	4.9	5.3
Finance, insurance, and real estate	2.3	2.3	2.3
Services	4.1	4.0	3.9
Government workers	2.0	2.1	2.0
Agricultural wage and salary workers	5.7	7.7	8.3
Educational attainment (1)			
Less than a high school diploma	6.8	6.6	6.5
High school graduates, no college	3.5	3.3	3.3
Some college, less than a bachelor's degree	2.7	2.7	2.7
College graduates	1.7	1.7	1.7

1999 2000

Selected categories	Dec.	Jan.	Feb.
Characteristic			
Total, 16 years and over	4.1	4.0	4.1
Both sexes, 16 to 19 years	13.8	12.6	14.1
Men, 20 years and over	3.3	3.3	3.4
Women, 20 years and over	3.6	3.7	3.5
White, total	3.5	3.4	3.6
Both sexes, 16to 19 years	12.2	10.8	12.5
Men, 16to 19 years	13.3	12.4	14.4
Women, 16to 19 years	10.9	9.1	10.4
Men, 20 years and over	2.8	2.8	2.9
Women, 20 years and over	3.0	3.1	3.1
Black, total	7.9	8.2	7.8
Both sexes, 16 to 19 years	25.3	23.9	24.3
Men, 16 to 19 years	27.5	24.0	22.3
Women, 16 to 19 years	23.0	23.8	26.6
Men, 20 years and over	7.0	7.4	7.1
Women, 20 years and over	6.7	7.2	6.5
Hispanic origin, total	5.9	5.6	5.7
Married men, spouse present	2.2	2.0	2.1
Married women, spouse present	2.5	2.6	2.6
Women who maintain families	6.2	6.2	6.1
Full-time workers	3.9	3.9	3.9
Part-time workers	4.9	4.6	4.9
Industry			
Nonagricultural wage and salary workers	4.1	4.2	4.2
Mining	4.1	2.6	4.0
Construction	6.6	6.4	7.5
Manufacturing	3.6	3.2	3.3
Durable goods	3.6	2.8	3.0
Nondurable goods	3.5	3.9	3.8
Transportation and public utilities	3.0	3.7	3.2
Wholesale and retail trade	5.2	5.1	5.3
Finance, insurance, and real estate	2.1	2.5	2.9
Services	3.8	4.2	3.7
Government workers	2.1	2.1	2.2
Agricultural wage and salary workers	7.1	5.0	6.5
Educational attainment(1)			
Less than a high school diploma	6.0	6.6	6.0
High school graduates, no college	3.5	3.5	3.5

Selected categories	Mar.	Apr.	May
Some college, less than a bachelor's degree	2.5	2.6	2.9
College graduates	1.8	1.8	1.6

Selected categories	2000 Mar.	2000 Apr.	2000 May
Characteristic			
Total, 16 years and over	4.1	3.9	4.1
Both sexes, 16 to 19 years	13.3	12.7	12.5
Men, 20 years and over	3.3	3.2	3.4
Women, 20 years and over	3.6	3.5	3.8
White, total	3.6	3.5	3.5
Both sexes, 16to 19 years	11.7	11.6	10.6
Men, 16to 19 years	11.3	13.0	10.7
Women, 16to 19 years	12.1	10.0	10.5
Men, 20 years and over	2.9	2.8	2.8
Women, 20 years and over	3.2	3.1	3.3
Black, total	7.3	7.2	8.0
Both sexes, 16 to 19 years	25.1	22.2	23.9
Men, 16 to 19 years	21.3	22.0	27.7
Women, 16 to 19 years	28.9	22.4	20.2
Men, 20 years and over	6.4	6.6	7.2
Women, 20 years and over	6.1	5.8	7.0
Hispanic origin, total	6.3	5.4	5.8
Married men, spouse present	2.0	1.8	1.9
Married women, spouse present	2.7	2.6	2.9
Women who maintain families	6.8	6.3	6.5
Full-time workers	3.8	3.8	3.9
Part-time workers	5.1	4.6	5.3
Industry			
Nonagricultural wage and salary workers	4.3	4.0	4.2
Mining	2.5	2.8	4.2
Construction	6.9	5.2	5.8
Manufacturing	3.9	4.0	3.7
Durable goods	3.0	3.9	3.6
Nondurable goods	5.2	4.1	3.7
Transportation and public utilities	3.1	2.9	3.2
Wholesale and retail trade	5.4	4.9	5.1
Finance, insurance, and real estate	2.4	2.6	2.4
Services	4.0	3.7	4.1
Government workers	1.7	1.7	2.0
Agricultural wage and salary workers	5.6	8.4	7.6

Educational attainment (1)			
Less than a high school diploma	6.9	6.1	7.0
High school graduates, no college	3.4	3.4	3.6
Some college, less than a bachelor's degree	2.7	2.6	2.5
College graduates	1.6	1.5	1.6

	2000		
Selected categories	June	July	Aug.
Characteristic			
Total, 16 years and over	4.0	4.0	4.1
Both sexes, 16 to 19 years	11.6	13.4	14.4
Men, 20 years and over	3.2	3.2	3.2
Women, 20 years and over	3.8	3.7	3.8
White, total	3.4	3.5	3.6
Both sexes, 16to 19 years	9.4	11.5	12.2
Men, 16to 19 years	11.2	12.6	13.3
Women, 16to 19 years	7.4	40.3	11.0
Men, 20 years and over	2.8	2.7	2.7
Women, 20 years and over	3.2	3.3	3.3
Black, total	7.9	7.7	8.0
Both sexes, 16 to 19 years	25.4	26.6	27.8
Men, 16 to 19 years	32.0	25.0	33.7
Women, 16 to 19 years	18.2	27.9	22.5
Men, 20 years and over	6.9	6.7	7.4
Women, 20 years and over	6.6	6.4	6.3
Hispanic origin, total	5.6	5.6	5.7
Married men, spouse present	1.9	2.0	2.0
Married women, spouse present	2.6	2.8	2.9
Women who maintain families	6.1	5.6	6.0
Full-time workers	3.8	3.7	4.0
Part-time workers	4.8	5.3	5.0
Industry			
Nonagricultural wage and salary workers	4.0	4.1	4.1
Mining	3.5	5.1	4.6
Construction	5.9	5.9	6.5
Manufacturing	3.4	3.6	3.5
Durable goods	3.5	3.3	3.1
Nondurable goods	3.1	4.0	4.3
Transportation and public utilities	2.7	3.2	3.1
Wholesale and retail trade	5.2	5.0	5.1
Finance, insurance, and			

real estate	2.3	2.1	2.5
Services	3.8	4.0	3.8
Government workers	2.5	2.1	2.4
Agricultural wage and salary workers	7.3	7.0	8.5
Educational attainment(1)			
Less than a high school diploma	6.4	6.4	6.1
High school graduates, no college	3.4	3.3	3.7
Some college, less than a bachelor's degree	2.9	2.8	2.9
College graduates	1.5	1.7	1.8

(1) Data refer to persons 25 years and over.

7. Duration of unemployment, monthly data seasonally adjusted
(Numbers in thousands)

Weeks of unemployment	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
Less than 5 weeks	2,622	2,568	2,599	2,582
5 to 14 weeks	1,950	1,832	1,798	1,805
15 weeks and over	1,637	1,480	1,463	1,412
15 to 26 weeks	763	755	747	708
27 weeks and over	875	725	716	704
Mean duration, in weeks	14.5	13.4	13.2	13.0
Median duration, in weeks	6.7	6.4	6.4	5.9

Weeks of unemployment	1999 Oct.	1999 Nov.	1999 Dec.	2000 Jan.
Less than 5 weeks	2,545	2,601	2,620	2,447
5 to 14 weeks	1,811	1,760	1,694	1,754
15 weeks and over	1,434	1,401	1,388	1,372
15 to 26 weeks	719	725	693	667
27 weeks and over	715	676	695	705
Mean duration, in weeks	13.2	13.0	12.9	13.2
Median duration, in weeks	6.3	6.2	5.9	5.7

Weeks of unemployment	2000 Feb.	2000 Mar.	2000 Apr.	2000 May
Less than 5 weeks	2,603	2,824	2,455	2,531
5 to 14 weeks	1,864	1,719	1,868	1,953
15 weeks and over	1,277	1,295	1,250	1,337
15 to 26 weeks	673	657	670	677
27 weeks and over	604	637	580	660
Mean duration, in weeks	12.5	12.8	12.4	12.6
Median duration, in weeks	6.1	6.0	6.0	5.8

Weeks of unemployment	2000 June	2000 July	2000 Aug.

Less than 5 weeks	2,595	2,470	2,594
5 to 14 weeks	1,759	1,812	1,846
15 weeks and over	1,242	1,331	1,384
15 to 26 weeks	593	654	679
27 weeks and over	549	677	705
Mean duration, in weeks	12.4	13.3	13.0
Median duration, in weeks	5.8	6.0	8.2

8. Unemployed persons by reason for unemployment, monthly data seasonally adjusted
(Numbers in thousands)

Reason for unemployment	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
Job losers(1)	2,822	2,622	2,629	2,573
On temporary layoff	866	848	893	869
Not on temporary layoff	1,957	1,774	1,736	1,704
Job leavers	734	783	793	758
Reentrants	2,132	2,005	1942	1,967
New entrants	520	469	481	504
Percent of unemployed				
Job losers(1)	45.5	44.6	45.0	44.3
On temporary layoff	139	14.40	15.30	15.00
Not on temporary layoff	31.50	30.20	29.70	29.40
Job leavers	11.8	13.3	13.6	13.1
Reentrants	34.3	34.1	33.2	33.9
New entrants	8.4	8.0	8.2	8.7
Percent of civilian labor force				
Job losers(1)	2.1	1.9	1.9	1.8
Job leavers	.5	.6	.6	.5
Reentrants	1.5	1.4	1.4	1.4
New entrants	.4	.3	.3	.4

Reason for unemployment	1999 Oct.	1999 Nov.	1999 Dec.	2000 Jan.
Job losers(1)	2,518	2,493	2,401	2,477
On temporary layoff	802	851	795	739
Not on temporary layoff	1,716	1,642	1,606	1,739
Job leavers	778	821	825	776
Reentrants	1,958	1,935	2,036	2,043
New entrants	511	485	453	393
Percent of unemployed				
Job losers(1)	43.7	43.5	42.0	43.5
On temporary layoff	13.90	15	13.90	13.0
Not on temporary layoff	29.80	28.60	28	30.6
Job leavers	13.5	14.3	14.4	13.6
Reentrants	34.0	33.7	35.6	35.9
New entrants	8.9	8.5	7.9	6.9

Percent of civilian labor force				
Job losers(1)	1.8	1.7	1.8	1.9
Job leavers	.6	.6	.6	.5
Reentrants	1.4	1.5	1.4	1.4
New entrants	.4	.3	.3	.3

	2000			
Reason for unemployment	Feb.	Mar.	Apr.	May
Job losers(1)	2,616	2,541	2,306	2,483
On temporary layoff	838	781	703	894
Not on temporary layoff	1,778	1,759	1,602	1,589
Job leavers	759	824	883	774
Reentrants	1,975	1,979	1,961	2,093
New entrants	387	434	408	500
Percent of unemployed				
Job losers(1)	45.6	44.0	41.9	42.4
On temporary layoff	14.6	13.50	12.8	15.30
Not on temporary layoff	31.0	30.50	29.1	27.20
Job leavers	13.2	14.3	15.1	13.2
Reentrants	34.4	34.3	35.6	35.8
New entrants	6.7	7.5	7.4	8.5
Percent of civilian labor force				
Job losers(1)	1.8	1.6	1.7	1.8
Job leavers	.6	.6	.6	.6
Reentrants	1.4	1.		
New entrants	.3	.3	.3	.4

	2000		
Reason for unemployment	June	July	Aug.
Job losers(1)	2,450	2,417	2,615
On temporary layoff	959	856	940
Not on temporary layoff	1491	1561	1674
Job leavers	671	799	780
Reentrants	2076	1961	1919
New entrants	343	402	514
Percent of unemployed			
Job losers(1)	44.2	43.3	44.8
On temporary layoff	17.30	15.30	16.10
Not on temporary layoff	26.90	28.00	28.70
Job leavers	12.1	14.3	13.4
Reentrants	37.5	35.1	32.9
New entrants	6.2	7.2	8.8
Percent of civilian labor force			

Job losers(1)	1.7	1.7	1.9
Job leavers	.5	.6	.6
Reentrants	1.5	1.4	1.4
New entrants	.2	.3	.4

(1) Includes persons who completed temporary jobs.

9. Unemployment rates by sex and age, monthly data seasonally adjusted

(Civilian workers)

Sex and age	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
Total, 16 years and over	4.5	4.2	4.2	4.2
16 to 24 years	10.4	9.9	9.6	10.0
16 to 19 years	14.6	13.9	13.5	14.6
16 to 17 years	17.2	16.3	15.9	16.1
18 to 19 years	12.8	12.4	12.1	13.8
20 to 24 years	7.9	7.5	7.3	7.2
25 years and over	3.4	3.1	3.2	3.1
25 to 54 years	3.5	3.2	3.2	3.2
55 years and over	2.7	2.8	2.7	2.6
Men, 16 years and over	4.4	4.1	4.1	4.0
16 to 24 years	11.1	10.3	9.9	9.9
16 to 19 years	16.2	14.7	13.9	14.6
16 to 17 years	19.1	17.0	16.2	16.6
18 to 19 years	14.1	13.1	12.6	13.2
20 to 24 years	8.1	7.7	7.6	7.2
25 years and over	3.2	3.0	3.1	3.0
25 to 54 years	3.3	3.0	3.1	3.0
55 years and over	2.8	2.8	2.9	2.9
Women, 16 years and over	4.6	4.3	4.3	4.3
16 to 24 years	9.8	9.5	9.3	10.0
16 to 19 years	12.9	13.2	13.2	14.7
16 to 17 years	15.1	15.5	15.6	15.6
18 to 19 years	11.5	11.6	11.6	14.5
20 to 24 years	7.8	7.2	7.0	7.2
25 years and over	3.6	3.3	3.3	3.2
25 to 54 years	3.8	3.4	3.4	3.4
55 years and over	2.6	2.8	2.4	2.1

Sex and age	1999 Oct.	1999 Nov.	1999 Dec.	2000 Jan.
Total, 16 years and over	4.1	4.1	4.1	4.0
16 to 24 years	10.0	10.0	9.8	9.3
16 to 19 years	13.9	14.0	13.8	12.6
16 to 17 years	15.9	16.5	16.5	14.0
18 to 19 years	12.4	12.3	12.1	11.4
20 to 24 years	7.7	7.7	7.4	7.4
25 years and over	3.0	3.0	3.0	3.0
25 to 54 years	3.1	3.1	3.0	3.1
55 years and over	2.7	2.6	2.7	2.8
Men, 16 years and over	4.1	4.0	4.0	3.9
16 to 24 years	10.4	10.2	10.6	9.7
16 to 19 years	14.2	14.9	15.2	14.0
16 to 17 years	15.5	16.9	17.7	14.3
18 to 19 years	13.2	13.6	13.5	13.7

20 to 24 years	8.2	7.5	7.8	7.2
25 years and over	2.9	2.8	2.8	2.8
25 to 54 years	3.0	2.9	2.9	2.9
55 years and over	2.8	2.6	2.5	2.5
Women, 16 years and over	4.2	4.2	4.1	4.2
16 to 24 years	9.6	9.8	8.9	8.9
16 to 19 years	13.4	13.0	12.2	11.1
16 to 17 years	16.3	16.1	15.1	13.7
18 to 19 years	11.4	10.8	10.5	8.9
20 to 24 years	7.2	7.9	7.0	7.6
25 years and over	3.1	3.1	3.2	3.2
25 to 54 years	3.2	3.3	3.2	3.3
55 years and over	2.5	2.6	2.9	3.1

	2000			
Sex and age	Feb.	Mar.	Apr.	May
Total, 16 years and over	4.1	4.1	3.9	4.1
16 to 24 years	10.0	9.7	9.3	9.8
16 to 19 years	14.1	13.3	12.7	12.5
16 to 17 years	15.9	15.3	14.6	16.0
18 to 19 years	12.8	12.1	11.4	10.4
20 to 24 years	7.5	7.6	7.2	8.2
25 years and over	3.0	3.0	2.9	3.0
25 to 54 years	3.0	3.0	3.0	3.1
55 years and over	3.0	2.7	2.4	2.4
Men, 16 years and over	4.1	3.8	3.8	3.9
16 to 24 years	10.3	9.2	9.6	10.0
16 to 19 years	15.5	12.4	13.6	13.1
16 to 17 years	17.3	15.1	15.8	16.9
18 to 19 years	13.9	10.5	12.4	10.8
20 to 24 years	7.3	7.4	7.3	8.3
25 years and over	2.9	2.8	2.7	2.8
25 to 54 years	2.9	2.8	2.7	2.8
55 years and over	2.8	2.8	2.7	2.6
Women, 16 years and over	4.1	4.3	4.0	4.3
16 to 24 years	9.6	10.2	8.9	9.5
16 to 19 years	12.6	14.4	11.6	11.8
16 to 17 years	14.3	15.4	13.3	15.0
18 to 19 years	11.6	13.7	10.4	9.9
20 to 24 years	7.8	7.7	7.2	8.2
25 years and over	3.0	3.2	3.0	3.3
25 to 54 years	3.0	3.3	3.2	3.5
55 years and over	3.3	2.7	2.0	2.3

	2000		
Sex and age	June	July	Aug.
Total, 16 years and over	4.0	4.0	4.1
16 to 24 years	9.0	9.2	9.4
16 to 19 years	11.6	13.4	14.4
16 to 17 years	13.1	16.5	17.1
18 to 19 years	10.6	11.5	12.6
20 to 24 years	7.5	6.8	6.4
25 years and over	3.0	3.0	3.1
25 to 54 years	3.1	3.2	3.2
55 years and over	2.3	2.4	2.6

Men, 16 years and over	3.9	3.8	4.0
16 to 24 years	9.5	9.6	10.1
16 to 19 years	14.1	14.0	16.0
16 to 17 years	15.6	17.4	16.9
18 to 19 years	13.3	11.9	15.5
20 to 24 years	6.8	7.1	6.7
25 years and over	2.8	2.8	2.8
25 to 54 years	2.9	2.8	2.9
55 years and over	2.2	2.4	2.7
Women, 16 years and over	4.1	4.3	4.3
16 to 24 years	8.5	8.9	8.6
16 to 19 years	8.9	12.8	12.6
16 to 17 years	10.4	15.5	17.3
18 to 19 years	7.8	11.0	9.4
20 to 24 years	8.2	6.5	6.2
25 years and over	3.2	3.3	3.5
25 to 54 years	3.4	3.5	3.6
55 years and over	2.4	2.3	2.6

10. Unemployment rates by State, seasonally adjusted

State	July 1999	June 2000	July 2000 (p)
Alabama	4.8	3.8	4.1
Alaska	6.5	6.1	5.5
Arizona	4.6	3.8	3.6
Arkansas	4.4	4.0	4.1
California	5.1	5.3	5.0
Colorado	2.8	2.3	2.7
Connecticut	3.1	2.3	2.4
Delaware	3.5	3.5	3.8
District of Columbia	5.9	4.4	5.0
Florida	3.7	3.9	3.7
Georgia	4.0	3.6	3.3
Hawaii	5.5	4.0	4.0
Idaho	4.3	4.4	4.4
Illinois	4.4	4.2	4.3
Indiana	2.9	3.5	3.6
Iowa	2.6	2.2	2.1
Kansas	2.8	3.3	3.4
Kentucky	4.5	3.8	3.8
Louisiana	5.0	4.8	4.5
Maine	4.0	3.4	3.4
Maryland	3.5	3.3	3.2
Massachusetts	3.2	2.6	2.9
Michigan	3.7	3.3	3.6
Minnesota	3.0	2.3	2.5
Mississippi	5.0	6.1	5.6
Missouri	3.5	2.6	2.4
Montana	5.1	4.8	5.1
Nebraska	2.9	2.9	2.8
Nevada	4.7	3.5	3.5
New Hampshire	2.6	2.8	3.1
New Jersey	4.7	3.4	3.7

New Mexico	5.5	5.5	5.4
New York	5.2	4.5	4.2
North Carolina	3.1	3.4	3.2
North Dakota	3.6	2.6	2.6
Ohio	4.4	4.2	4.1
Oklahoma	3.2	3.0	3.0
Oregon	5.8	4.9	5.0
Pennsylvania	4.4	4.1	4.0
Rhode Island	4.2	3.9	3.9
South Carolina	4.4	3.8	4.0
South Dakota	2.9	2.4	2.3
Tennessee	4.1	3.7	3.6
Texas	4.6	4.4	4.1
Utah	3.8	3.0	3.0
Vermont	3.2	2.6	2.7
Virginia	2.8	2.5	2.5
Washington	4.8	4.7	4.8
West Virginia	6.6	5.8	5.4
Wisconsin	2.9	3.7	3.7
Wyoming	4.9	3.8	4.0

(p) = preliminary

11. Employment of workers on nonfarm payrolls by State, seasonally adjusted

(In thousand)

State	July 1999	June 2000	July 2000 (p)
Alabama	1,927.8	1,944.3	1,950.7
Alaska	278.0	282.7	282.9
Arizona	2,170.3	2,251.0	2,265.5
Arkansas	1,140.4	1,172.4	1,171.0
California	14,001.8	14,403.9	14,450.9
Colorado	2,146.7	2,198.6	2,203.5
Connecticut	1,675.2	1,696.4	1,696.2
Delaware	409.5	425.2	425.3
District of Columbia	615.3	619.5	616.4
Florida	6,885.3	7,165.3	7,181.2
Georgia	3,899.8	3,995.5	4,001.1
Hawaii	534.9	544.6	545.5
Idaho	543.2	559.7	561.4
Illinois	5,972.5	6,012.0	6,016.8
Indiana	2,980.7	3,002.6	2,993.3
Iowa	1,467.3	1,493.1	1,489.9
Kansas	1,326.5	1,349.5	1,351.8
Kentucky	1,793.2	1,839.3	1,835.3
Louisiana	1,896.0	1,908.2	1,911.2
Maine	586.1	596.8	600.1
Maryland	2,368.4	2,441.4	2,423.9
Massachusetts	3,243.3	3,291.7	3,299.1
Michigan	4,541.6	4,578.2	4,585.5
Minnesota	2,614.4	2,649.4	2,650.3
Mississippi	1,161.2	1,154.7	1,153.4
Missouri	2,727.8	2,754.7	2,737.5

Montana	383.2	390.9	391.0
Nebraska	897.8	894.0	883.0
Nevada	988.8	1,025.0	1,030.4
New Hampshire	606.8	611.8	611.7
New Jersey	3,869.8	3,932.9	3,921.8
New Mexico	730.6	743.9	742.1
New York	8,464.1	8,614.6	8,614.5
North Carolina	3,885.5	3,910.9	3,937.5
North Dakota	323.6	323.8	323.8
Ohio	5,558.4	5,581.7	5,590.5
Oklahoma	1,460.5	1,488.5	1,492.0
Oregon	1,580.1	1,593.6	1,600.1
Pennsylvania	5,584.5	5,607.0	5,608.1
Rhode Island	465.6	471.7	473.9
South Carolina	1,835.1	1,877.4	1,872.9
South Dakota	372.2	376.3	377.4
Tennessee	2,679.2	2,722.1	2,724.9
Texas	9,137.0	9,407.0	9,384.4
Utah	1,051.8	1,071.8	1,072.5
Vermont	290.6	295.0	296.2
Virginia	3,406.4	3,473.7	3,463.7
Washington	2,645.9	2,690.9	2,696.6
West Virginia	724.7	730.6	730.3
Wisconsin	2,482.9	2,824.8	2,818.1
Wyoming	233.8	233.8	238.8

(p) = preliminary

NOTE: Some data in this table may differ from data published elsewhere because of the continual updating of the data base.

12. Employment of workers on nonfarm payrolls by industry, monthly data seasonally adjusted

(In thousands)

Industry	Annual average		1999
	1998	1999	Aug.
TOTAL	125,865	128,786	129,057
PRIVATE SECTOR	106,042	108,616	108,846
GOODS-PRODUCING	25,414	25,482	25,430
Mining	590	535	526
Metal mining	49	45	44
Oil and gas extraction	339	293	286
Nonmetallic minerals, except fuels	110	112	112
Construction	6,020	6,404	6,401
General building contractors	1,377	1,450	1,447
Heavy construction, except building	840	869	865
Special trades contractors	3,804	4,084	4,089
Manufacturing	18,805	18,543	18,503
Production workers	12,952	12,739	12,706
Durable goods	11,205	11,103	11,097

Production workers	7,666	7,590	7,590
Lumber and wood products	814	828	829
Furniture and fixtures	533	548	551
Stone, clay, and glass products	562	563	563
Primary metal industries	715	700	699
Fabricated metal products	1,509	1,517	1,515
Industrial machinery and equipment	2,206	2,141	2,135
Computer and office equipment	382	370	370
Electronic and other electrical equipment	1,707	1,670	1,669
Electronic components and accessories	660	636	637
Transportation equipment	1,893	1,884	1,887
Motor vehicles and equipment	995	1,019	1,026
Aircraft and parts	525	495	488
Instruments and related products	873	856	854
Miscellaneous manufacturing industries	395	395	395
Nondurable goods	7,600	7,440	7,406
Production workers	5,287	5,149	5,116
Food and kindred products	1,683	1,677	1,667
Tobacco products	41	39	36
Textile mill products	598	560	556
Apparel and other textile products	766	692	681
Paper and allied products	677	668	667
Printing and publishing	1,565	1,553	1,552
Chemicals and allied products	1,043	1,034	1,030
Petroleum and coal products	139	134	132
Rubber and miscellaneous plastics products	1,005	1,006	1,008
Leather and leather products	84	78	77
SERVICE-PRODUCING	100,451	103,304	103,627
Transportation and public utilities	6,611	6,826	6,848
Transportation	4,273	4,409	4,426
Railroad transportation	231	230	227
Local and interurban passenger transit	469	485	488
Trucking and warehousing	1,744	1,805	1,810
Water transportation	181	187	188
Transportation by air	1,181	1,227	1,234
Pipelines, except natural gas	14	13	13
Transportation services	454	463	466
Communications and public utilities	2,338	2,416	2,422
Communications	1,477	1,552	1,558

Electric, gas, and sanitary services	861	865	864
Wholesale trade	6,800	6,924	6,946
Retail trade	22,295	22,788	22,841
Building materials and garden supplies	948	989	992
General merchandise stores	2,730	2,771	2,768
Department stores	2,415	2,431	2,426
Food stores	3,484	3,495	3,498
Automotive dealers and service stations	2,332	2,369	2,369
New and used car dealers	1,047	1,079	1,084
Apparel and accessory stores	1,141	1,174	1,181
Furniture and home furnishings stores	1,025	7,082	1,090
Eating and drinking places	7,768	7,940	7,958
Miscellaneous retail establishments	2,868	2,969	2,985
Finance, insurance, and real estate	7,389	7,569	7,590
Finance	3,588	3,691	3,704
Depository institutions	2,046	2,061	2,063
Commercial banks	1,472	1,476	1,476
Savings institutions	256	252	251
Nondepository institutions	658	710	716
Security and commodity brokers	647	688	695
Holding and other investment offices	238	231	230
Insurance	2,335	2,371	2,375
Insurance carriers	1,591	1,611	1,611
Insurance agents, brokers, and service	744	761	764
Real estate	1,465	1,507	1,511
Services(1)	37,533	39,027	39,191
Agricultural services	708	766	764
Hotels and other lodging places	1,789	1,848	1,857
Personal services	1,201	1,233	1,237
Business services	8,618	9,267	9,339
Services to buildings	950	985	992
Personnel supply services	3,278	3,601	3,626
Help supply services	2,956	3,228	3,251
Computer and data processing services	1,615	1,831	1,857
Auto repair services and parking	1,145	1,184	1,185
Miscellaneous repair services	376	377	376
Motion pictures	576	610	618
Amusement and recreation services	1,594	1,660	1,664

Health services	9,853	9,989	10,008
Offices and clinics of medical doctors	1,806	1,877	1,885
Nursing and personal care facilities	1,772	1,785	1,786
Hospitals	3,930	3,982	3,987
Home health care services	666	636	636
Legal services	971	997	999
Educational services	2,178	2,276	2,292
Social services	2,646	2,800	2,808
Child day care services	621	695	701
Residential care	744	775	780
Museums and botanical and zoological gardens	94	98	98
Membership organizations	2,372	2,425	2,426
Engineering and management services	3,139	3,254	3,276
Engineering and architectural services	908	953	957
Management and public relations	1,000	1,036	1,045
Government	19,823	20,170	20,211
Federal	2,686	2,269	2,655
Federal, except Postal Service	1,819	1,796	1,783
State	4,612	4,695	4,698
Education	1,922	1,968	1,972
Other State government	2,690	2,727	2,726
Local	12,525	12,806	12,858
Education	7,085	7,272	7,305
Other local government	5,440	5,534	5,553

Industry	1999		
	Sept.	Oct.	Nov.
TOTAL	129,265	129,523	129,788
PRIVATE SECTOR	109,042	109,275	109,517
GOODS-PRODUCING	25,460	25,483	25,527
Mining	527	529	527
Metal mining	45	45	45
Oil and gas extraction	287	289	288
Nonmetallic minerals, except fuels	112	112	112
Construction	6,439	6,470	6,516
General building contractors	1,458	1,464	1,470
Heavy construction, except building	866	872	876
Special trades contractors	4,115	4,134	4,170

Manufacturing	18,494	18,484	18,484
Production workers	12,700	12,702	12,702
Durable goods	11,090	11,083	11,085
Production workers	7,580	7,581	7,579
Lumber and wood products	830	831	831
Furniture and fixtures	551	553	553
Stone, clay, and glass products	563	562	564
Primary metal industries	697	697	698
Fabricated metal products	1,518	1,519	1,520
Industrial machinery and equipment	2,133	2,130	2,131
Computer and office equipment	370	369	370
Electronic and other electrical equipment	1,670	1,672	1,670
Electronic components and accessories	636	638	638
Transportation equipment	1,880	1,873	1,870
Motor vehicles and equipment	1,025	1,022	1,022
Aircraft and parts	483	478	473
Instruments and related products	852	849	850
Miscellaneous manufacturing industries	396	397	398
Nondurable goods	7,404	7,401	7,399
Production workers	5,120	5,121	5,123
Food and kindred products	1,673	1,673	1,675
Tobacco products	38	38	38
Textile mill products	552	550	552
Apparel and other textile products	678	674	672
Paper and allied products	666	665	665
Printing and publishing	1,551	1,551	1,549
Chemicals and allied products	1,031	1,032	1,031
Petroleum and coal products	133	133	132
Rubber and miscellaneous plastics products	1,005	1,008	1,009
Leather and leather products	77	77	76
SERVICE-PRODUCING	103,805	104,040	104,261
Transportation and public utilities	6,866	6,875	6,898
Transportation	4,436	4,441	4,453
Railroad transportation	226	226	226
Local and interurban passenger transit	488	489	490
Trucking and warehousing	1,816	1,818	1,823
Water transportation	189	190	190
Transportation by air	1,238	1,241	1,246
Pipelines, except natural			

gas	13	13	13
Transportation services	466	464	465
Communications and public utilities	2,430	2,434	2,445
Communications	1,565	1,572	1,581
Electric, gas, and sanitary services	865	862	864
Wholesale trade	6,962	6,973	6,989
Retail trade	22,844	22,863	22,893
Building materials and garden supplies	994	1,004	1,038
General merchandise stores	2,757	2,752	2,752
Department stores	2,414	2,408	2,406
Food stores	3,495	3,496	3,498
Automotive dealers and service stations	2,372	2,377	2,380
New and used car dealers	1,087	1,089	1,092
Apparel and accessory stores	1,183	1,186	1,190
Furniture and home furnishings stores	1,092	1,093	1,091
Eating and drinking places	7,956	7,950	7,966
Miscellaneous retail establishments	2,995	3,005	3,008
Finance, insurance, and real estate	7,589	7,599	7,604
Finance	3,702	3,704	3,707
Depository institutions	2,063	2,063	2,061
Commercial banks	1,476	1,475	1,473
Savings institutions	250	250	250
Nondepository institutions	711	706	704
Security and commodity brokers	697	703	709
Holding and other investment offices	231	232	233
Insurance	2,376	2,378	2,375
Insurance carriers	1,610	1,612	1,608
Insurance agents, brokers, and service	766	766	767
Real estate	1,511	1,517	1,522
Services(1)	39,321	39,482	39,606
Agricultural services	770	774	782
Hotels and other lodging places	1,863	1,863	1,868
Personal services	1,243	1,247	1,252
Business services	9,404	9,465	9,502
Services to buildings	994	997	998
Personnel supply services	3,678	3,712	3,734
Help supply services	3,298	3,327	3,343
Computer and data processing services	1,866	1,874	1,880
Auto repair services and parking	1,186	1,191	1,191

Miscellaneous repair services	377	379	379
Motion pictures	619	624	625
Amusement and recreation services	1,672	1,691	1,701
Health services	10,015	10,027	10,041
Offices and clinics of medical doctors	1,888	1,893	1,898
Nursing and personal care facilities	1,785	1,785	1,785
Hospitals	3,989	3,992	3,992
Home health care services	635	636	637
Legal services	1,000	1,003	1,005
Educational services	2,294	2,299	2,305
Social services	2,823	2,845	2,868
Child day care services	701	708	721
Residential care	785	790	795
Museums and botanical and zoological gardens	98	99	99
Membership organizations	2,430	2,431	2,434
Engineering and management services	3,283	3,300	3,310
Engineering and architectural services	956	964	969
Management and public relations	1,044	1,054	1,058
Government	20,223	20,248	20,271
Federal	2,655	2,647	2,646
Federal, except Postal Service	1,785	1,779	1,780
State	4,714	4,722	4,723
Education	1,978	1,979	1,980
Other State government	2,736	2,743	2,743
Local	12,854	12,879	12,902
Education	7,299	7,308	7,323
Other local government	5,555	5,571	5,579

Industry	1999	2000	
	Dec.	Jan.	Feb.
TOTAL	130,038	130,387	130,482
PRIVATE SECTOR	109,730	110,036	110,088
GOODS-PRODUCING	25,561	25,677	25,624
Mining	530	530	533
Metal mining	45	45	45
Oil and gas extraction	291	293	296
Nonmetallic minerals, except fuels	111	111	111
Construction	6,552	6,652	6,618

General building contractors	1,474	1,498	1,491
Heavy construction, except building	882	892	885
Special trades contractors	4,196	4,262	4,242
Manufacturing	18,479	18,495	18,473
Production workers	12,701	12,713	12,697
Durable goods	11,087	11,099	11,088
Production workers	7,579	7,592	7,592
Lumber and wood products	831	830	832
Furniture and fixtures	552	553	553
Stone, clay, and glass products	565	568	567
Primary metal industries	698	699	699
Fabricated metal products	1,521	1,523	1,525
Industrial machinery and equipment	2,132	2,130	2,131
Computer and office equipment	370	369	368
Electronic and other electrical equipment	1,873	1,679	1,684
Electronic components and accessories	640	642	645
Transportation equipment	1,867	1,871	1,855
Motor vehicles and equipment	1,023	1,027	1,029
Aircraft and parts	470	469	453
Instruments and related products	849	847	844
Miscellaneous manufacturing industries	399	399	398
Nondurable goods	7,392	7,396	7,385
Production workers	5,122	5,121	5,105
Food and kindred products	1,674	1,681	1,672
Tobacco products	38	38	37
Textile mill products	549	548	549
Apparel and other textile products	669	666	665
Paper and allied products	665	664	663
Printing and publishing	1,548	1,549	1,550
Chemicals and allied products	1,030	1,031	1,031
Petroleum and coal products	132	132	132
Rubber and miscellaneous plastics products	1,011	1,011	1,010
Leather and leather products	76	76	76
SERVICE-PRODUCING	104,477	104,710	104,856
Transportation and public utilities	6,911	6,925	6,937
Transportation	4,459	4,470	4,479
Railroad transportation	226	225	225
Local and interurban			

passenger transit	491	493	494
Trucking and warehousing	1,818	1,827	1,828
Water transportation	192	192	196
Transportation by air	1,253	1,256	1,259
Pipelines, except natural gas	13	13	12
Transportation services	468	464	465
Communications and public utilities	2,452	2,455	2,458
Communications	1,588	1,591	1,598
Electric, gas, and sanitary services	864	864	860
Wholesale trade	7,002	7,005	7,011
Retail trade	22,936	22,973	22,987
Building materials and garden supplies	1,012	1,016	1,020
General merchandise stores	2,766	2,765	2,762
Department stores	2,416	2,419	2,417
Food stores	3,501	3,501	3,503
Automotive dealers and service stations	2,386	2,399	2,394
New and used car dealers	1,094	1,097	1,100
Apparel and accessory stores	1,182	1,176	1,184
Furniture and home furnishings stores	1,098	1,099	1,102
Eating and drinking places	7,986	7,998	7,992
Miscellaneous retail establishments	3,005	3,019	3,021
Finance, **insurance**, and real estate	7,613	7,612	7,624
Finance	**3**,710	3,709	3,717
Depository institutions	2,059	2,058	2,057
Commercial banks	1,471	1,470	1,469
Savings institutions	248	247	245
Nondepository institutions	704	699	699
Security and commodity brokers	713	716	723
Holding and other investment offices	234	236	238
Insurance	2,378	2,372	2,373
Insurance carriers	1,610	1,606	1,606
Insurance agents, brokers, and service	768	766	767
Real estate	1,525	1,531	1,534
Services(1)	39,707	39,844	39,914
Agricultural services	782	806	796
Hotels and other lodging places	1,868	1,866	1,868
Personal services	1,257	1,263	1,265
Business services	9,538	9,571	9,615
Services to buildings	997	997	1,000
Personnel supply			

services	3,748	3,753	3,773
Help supply services	3,358	3,361	3,382
Computer and data processing services	1,888	1,896	1,906
Auto repair services and parking	1,192	1,194	1,195
Miscellaneous repair services	382	382	384
Motion pictures	624	626	623
Amusement and recreation services	1,703	1,721	1,723
Health services	10,053	10,066	10,078
Offices and clinics of medical doctors	1,903	1,910	1,914
Nursing and personal care facilities	1,787	1,788	1,790
Hospitals	3,997	4,001	4,002
Home health care services	637	638	639
Legal services	1,007	1,008	1,007
Educational services	2,309	2,308	2,309
Social services	2,884	2,905	2,912
Child day care services	729	737	740
Residential care	800	803	807
Museums and botanical and zoological gardens	99	100	100
Membership organizations	2,438	2,439	2,439
Engineering and management services	3,327	3,344	3,354
Engineering and architectural services	974	982	954
Management and public relations	1,068	1,074	1,077
Government	20,308	20,351	20,394
Federal	2,646	2,663	2,700
Federal, except Postal Service	1,780	1,797	1,835
State	4,727	4,725	4,728
Education	1,983	1,951	1,981
Other State government	2,744	2,744	2,747
Local	12,935	12,963	12,966
Education	7,343	7,356	7,355
Other local government	5,592	5,607	5,611

Industry	2000		
	Mar.	Apr.	May
TOTAL	131,009	131,419	131,590
PRIVATE SECTOR	110,462	110,752	110,578
GOODS-PRODUCING	25,738	25,725	25,684
Mining	536	539	539

Metal mining	45	45	44
Oil and gas extraction	300	303	305
Nonmetallic minerals, except fuels	111	111	110
Construction	6,726	6,694	6,666
General building contractors	1,508	1,497	1,497
Heavy construction, except building	905	899	888
Special trades contractors	4,313	4,298	4,281
Manufacturing	18,476	16,492	18,479
Production workers	12,683	12,689	12,682
Durable goods	11,094	11,104	11,106
Production workers	7,580	7,584	7,584
Lumber and wood products	830	830	828
Furniture and fixtures	555	557	558
Stone, clay, and glass products	568	567	566
Primary metal industries	701	699	699
Fabricated metal products	1,526	1,534	1,535
Industrial machinery and equipment	2,124	2,126	2,125
Computer and office equipment	366	364	360
Electronic and other electrical equipment	1,682	1,691	1,693
Electronic components and accessories	546	651	654
Transportation equipment	1,865	1,859	1,863
Motor vehicles and equipment	1,028	1,026	1,026
Aircraft and parts	467	461	483
Instruments and related products	844	844	845
Miscellaneous manufacturing industries	397	397	394
Nondurable goods	7,382	7,388	7,373
Production workers	5,103	5,105	5,098
Food and kindred products	1,671	1,678	1,675
Tobacco products	35	37	37
Textile mill products	549	548	545
Apparel and other textile products	665	665	660
Paper and allied products	662	662	661
Printing and publishing	1,551	1,554	1,552
Chemicals and allied products	1,031	1,030	1,028
Petroleum and coal products	132	132	132
Rubber and miscellaneous plastics products	1,010	1,007	1,008
Leather and leather products	76	75	75
SERVICE-PRODUCING	105,271	105,694	105,906

Transportation and public utilities	6,953	6,970	6,962
Transportation	4,492	4,509	4,501
Railroad transportation	222	221	219
Local and interurban passenger transit	494	498	498
Trucking and warehousing	1,833	1,839	1,834
Water transportation	197	200	200
Transportation by air	1,268	1,270	1,269
Pipelines, except natural gas	12	12	12
Transportation services	466	469	469
Communications and public utilities	2,461	2,461	2,461
Communications	1,602	1,604	1,606
Electric, gas, and sanitary services	859	857	855
Wholesale trade	7,017	7,055	7,048
Retail trade	23,027	23,197	23,064
Building materials and garden supplies	1,034	1,032	1,025
General merchandise stores	2,756	2,791	2,744
Department stores	2,409	2,443	2,388
Food stores	3,502	3,522	3,516
Automotive dealers and service stations	2,407	2,410	2,408
New and used car dealers	1,105	1,106	1,107
Apparel and accessory stores	1,188	1,195	1,195
Furniture and home furnishings stores	1,111	1,113	1,113
Eating and drinking places	8,000	8,097	8,028
Miscellaneous retail establishments	3,029	3,037	3,035
Finance, **insurance**, and real estate	7,621	7,610	7,600
Finance	3,713	3,709	3,703
Depository institutions	2,054	2,052	2,044
Commercial banks	1,466	1,464	1,456
Savings institutions	243	243	243
Nondepository institutions	692	686	684
Security and commodity brokers	728	732	736
Holding and other investment offices	239	239	239
Insurance	2,373	2,365	2,361
Insurance carriers	1,605	1,597	1,594
Insurance agents, brokers, and service	768	768	767
Real estate	1,535	1,536	1,536
Services(1)	40,090	40,195	40,220
Agricultural services	812	801	790

Industry	2000 June	July (p)	Aug. (p)
Hotels and other lodging places	1,885	1,902	1,904
Personal services	1,265	1,272	1,262
Business services	9,681	9,735	9,715
Services to buildings	1,004	1,001	996
Personnel supply services	3,817	3,885	3,855
Help supply services	3,418	3,485	3,440
Computer and data processing services	1,915	1,927	1,929
Auto repair services and parking	1,192	1,195	1,192
Miscellaneous repair services	384	383	383
Motion pictures	630	634	632
Amusement and recreation services	1,729	1,752	1,755
Health services	10,091	10,093	10,104
Offices and clinics of medical doctors	1,920	1,925	1,928
Nursing and personal care facilities	1,791	1,789	1,788
Hospitals	4,004	3,999	4,005
Home health care services	639	641	641
Legal services	1,007	1,004	1,006
Educational services	2,329	2,329	2,356
Social services	2,929	2,940	2,946
Child day care services	749	753	758
Residential care	810	812	816
Museums and botanical and zoological gardens	101	102	101
Membership organizations	2,440	2,439	2,438
Engineering and management services	3,369	3,368	3,390
Engineering and architectural services	985	987	995
Management and public relations	1,085	1,088	1,096
Government	20,547	20,667	21,012
Federal	2,816	2,885	3,238
Federal, except Postal Service	1,951	2,022	2,374
State	4,733	4,744	4,737
Education	1,982	1,990	1,983
Other State government	2,751	2,754	2,754
Local	12,998	13,038	13,037
Education	7,373	7,408	7,395
Other local government	5,625	5,630	5,642

TOTAL	131,647	131,596	131,491
PRIVATE SECTOR	110,845	111,009	111,026
GOODS-PRODUCING	25,700	25,756	25,677
Mining	539	539	539
Metal mining	44	43	43
Oil and gas extraction	306	307	307
Nonmetallic minerals, except fuels	110	110	109
Construction	6,668	6,673	6,673
General building contractors	1,498	1,498	1,503
Heavy construction, except building	877	881	883
Special trades contractors	4,293	4,294	4,287
Manufacturing	18,493	18,544	18,465
Production workers	12,683	12,733	12,660
Durable goods	11,120	11,156	11,115
Production workers	7,593	7,623	7,589
Lumber and wood products	827	823	818
Furniture and fixtures	558	565	557
Stone, clay, and glass products	568	571	567
Primary metal industries	699	698	694
Fabricated metal products	1,540	1,540	1,537
Industrial machinery and equipment	2,130	2,137	2,135
Computer and office equipment	360	361	363
Electronic and other electrical equipment	1,697	1,716	1,719
Electronic components and accessories	661	671	675
Transportation equipment	1,864	1,860	1,844
Motor vehicles and equipment	1,030	1,026	1,013
Aircraft and parts	460	460	458
Instruments and related products	844	849	848
Miscellaneous manufacturing industries	393	397	396
Nondurable goods	7,373	7,386	7,350
Production workers	5,090	5,110	5,071
Food and kindred products	1,679	1,681	1,676
Tobacco products	37	37	34
Textile mill products	542	543	541
Apparel and other textile products	652	656	646
Paper and allied products	663	662	661
Printing and publishing	1,558	1,560	1,559
Chemicals and allied products	1,028	1,026	1,021
Petroleum and coal			

products	132	131	132
Rubber and miscellaneous plastics products	1,008	1,014	1,006
Leather and leather products	74	76	74
SERVICE-PRODUCING	105,947	105,840	105,814
Transportation and public utilities	6,985	7,008	6,944
Transportation	4,510	4,537	4,549
Railroad transportation	217	219	219
Local and interurban passenger transit	493	501	499
Trucking and warehousing	1,834	1,847	1,850
Water transportation	202	200	204
Transportation by air	1,279	1,282	1,289
Pipelines, except natural gas	12	13	12
Transportation services	473	475	476
Communications and public utilities	2,475	2,471	2,395
Communications	1,619	1,616	1,539
Electric, gas, and sanitary services	856	855	856
Wholesale trade	7,049	7,048	7,058
Retail trade	23,122	23,196	23,161
Building materials and garden supplies	1,018	1,017	1,020
General merchandise stores	2,741	2,725	2,725
Department stores	2,386	2,371	2,378
Food stores	3,515	3,518	3,523
Automotive dealers and service stations	2,412	2,413	2,417
New and used car dealers	1,110	1,111	1,114
Apparel and accessory stores	1,197	1,207	1,202
Furniture and home furnishings stores	1,118	1,118	1,121
Eating and drinking places	8,071	8,135	8,094
Miscellaneous retail establishments	3,050	3,063	3,059
Finance, **insurance**, and real estate	7,588	7,589	7,614
Finance	**3** ,705	3,708	3,719
Depository institutions	2,042	2,037	2,037
Commercial banks	1,454	1,450	1,450
Savings institutions	242	240	240
Nondepository institutions	682	683	685
Security and commodity brokers	741	748	754
Holding and other investment offices	240	240	243
Insurance	2,359	2,356	2,358
Insurance carriers	1,593	1,587	1,589

Insurance agents, brokers, and service	766	769	769
Real estate	1,524	1,525	1,537
Services(1)	40,401	40,412	40,572
Agricultural services	788	794	796
Hotels and other lodging places	1,922	1,930	1,935
Personal services	1,271	1,273	1,282
Business services	9,773	9,770	9,811
Services to buildings	997	1,000	995
Personnel supply services	3,873	3,854	3,876
Help supply services	3,444	3,465	3,446
Computer and data processing services	1,933	1,948	1,956
Auto repair services and parking	1,191	1,194	1,200
Miscellaneous repair services	384	383	383
Motion pictures	635	634	638
Amusement and recreation services	1,789	1,794	1,803
Health services	10,116	10,143	10,157
Offices and clinics of medical doctors	1,928	1,930	1,932
Nursing and personal care facilities	1,786	1,787	1,794
Hospitals	4,008	4,018	4,021
Home health care services	642	645	644
Legal services	1,009	1,012	1,015
Educational services	2,374	2,379	2,379
Social services	2,945	2,916	2,950
Child day care services	760	765	765
Residential care	820	826	828
Museums and botanical and zoological gardens	103	103	103
Membership organizations	2,441	2,431	2,436
Engineering and management services	3,415	3,410	3,438
Engineering and architectural services	1,005	1,007	1,011
Management and public relations	1,110	1,105	1,113
Government	20,802	20,587	20,465
Federal	3,092	2,819	2,674
Federal, except Postal Service	2,230	1,954	1,805
State	4,716	4,734	4,734
Education	1,967	1,982	1,972
Other State government	2,749	2,752	2,762
Local	12,994	13,034	13,057
Education	7,361	7,387	7,381
Other local			

government	5,633	5,647	5,676

(1) Includes other industries not shown separately.

(p) = preliminary.

NOTE: See "Notes on the data" for a description of the most recent benchmark revision.

13. Average weekly hours of production or nonsupervisory workers on private nonfarm payrolls, by industry, monthly data seasonally adjusted

Industry	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
PRIVATE SECTOR	34.6	34.5	34.5	34.5
GOODS-PRODUCING	41.0	41.0	41.1	41.2
MINING	43.9	43.8	44.1	44.3
MANUFACTURING	41.7	41.7	41.8	41.8
Overtime hours	4.6	4.6	4.6	47.0
Durable goods	42.3	42.2	42.3	42.4
Overtime hours	4.8	4.8	48.0	4.9
Lumber and wood products	41.1	41.2	41.2	41.1
Furniture and fixtures	40.5	40.3	40.3	40.4
Stone, clay, and glass products	43.5	43.5	43.5	43.5
Primary metal industries	44.2	44.2	44.4	44.5
Blast furnaces and basic steel products	44.6	44.8	45.0	45.0
Fabricated metal products	42.3	42.2	42.3	42.3
Industrial machinery and equipment	42.8	42.2	42.3	42.4
Electronic and other electrical equipment	41.4	41.4	41.6	41.6
Transportation equipment	43.4	43.8	43.9	44.0
Motor vehicles and equipment	43.5	45.0	45.1	45.4
Instruments and related products	41.3	41.5	41.5	41.5
Miscellaneous manufacturing	39.9	39.8	40.0	39.9
Nondurable goods	40.9	40.9	41.0	41.0
Overtime hours	4.3	4.4	4.4	4.4
Food and kindred products	41.7	41.8	41.7	41.7
Textile mill products	41.0	40.9	41.0	40.9
Apparel and other textile products	37.3	37.5	37.4	37.4
Paper and allied products	43.4	43.5	43.6	43.4
Printing and publishing	38.3	38.2	38.3	38.3
Chemicals and allied products	43.2	43.0	43.2	43.2
Rubber and miscellaneous plastics products	41.7	41.7	41.7	41.8
Leather and leather products	37.6	37.8	37.9	37.5
SERVICE-PRODUCING	32.9	32.8	32.8	32.8
TRANSPORTATION AND PUBLIC UTILITIES	39.5	38.7	38.8	38.6

WHOLESALE TRADE	38.3	38.3	38.3	38.4
RETAIL TRADE	29.0	29.0	29.0	28.8

Industry	1999			2000
	Oct.	Nov.	Dec.	Jan.
PRIVATE SECTOR	34.5	34.5	34.5	34.5
GOODS-PRODUCING	41.1	41.3	41.0	41.1
MINING	44.1	44.2	44.3	44.7
MANUFACTURING	41.8	41.7	41.7	41.7
Overtime hours	4.7	4.7	47.0	4.6
Durable goods	42.3	42.2	42.2	42.3
Overtime hours	4.8	4.8	4.8	4.8
Lumber and wood products	41.1	41.1	41.0	41.1
Furniture and fixtures	40.1	39.9	40.2	40.2
Stone, clay, and glass products	43.5	43.8	43.5	43.6
Primary metal industries	44.3	44.3	44.4	44.5
Blast furnaces and basic steel products	45.2	45.3	45.4	45.3
Fabricated metal products	42.2	42.1	42.1	42.4
Industrial machinery and equipment	42.3	42.2	42.2	42.3
Electronic and other electrical equipment	41.6	41.4	41.5	41.6
Transportation equipment	43.8	43.6	43.4	43.8
Motor vehicles and equipment	45.0	44.7	44.5	45.0
Instruments and related products	41.5	41.5	41.5	41.3
Miscellaneous manufacturing	39.8	39.7	39.7	39.5
Nondurable goods	41.0	41.0	40.9	40.9
Overtime hours	4.5	4.5	4.5	4.4
Food and kindred products	41.9	41.8	41.7	41.6
Textile mill products	41.2	41.3	41.2	41.1
Apparel and other textile products	37.5	37.4	37.5	37.6
Paper and allied products	43.5	43.4	43.3	43.3
Printing and publishing	38.3	38.3	38.3	38.3
Chemicals and allied products	43.0	43.0	43.0	42.9
Rubber and miscellaneous plastics products	41.5	41.5	41.5	41.6
Leather and leather products	37.6	37.7	37.4	37.8
SERVICE-PRODUCING	32.9	32.8	32.9	32.9
TRANSPORTATION AND PUBLIC UTILITIES	38.4	38.3	38.4	38.4
WHOLESALE TRADE	38.6	38.4	38.5	38.6

RETAIL TRADE	29.0	29.0	29.1	29.1

Industry	2000			
	Feb.	Mar.	Apr.	May
PRIVATE SECTOR	34.6	34.5	34.6	34.4
GOODS-PRODUCING	41.3	41.2	41.5	40.9
MINING	44.7	44.7	45.3	44.1
MANUFACTURING	41.8	41.7	42.2	41.4
Overtime hours	4.7	4.6	4.9	4.5
Durable goods	42.3	42.3	42.8	42.0
Overtime hours	4.9	4.8	5.1	4.7
Lumber and wood products	41.0	40.9	41.2	40.7
Furniture and fixtures	40.3	40.2	40.6	40.3
Stone, clay, and glass products	43.5	43.4	43.6	43.0
Primary metal industries	44.5	44.4	44.9	43.8
Blast furnaces and basic steel products	45.4	45.2	45.0	44.7
Fabricated metal products	42.4	42.5	43.0	42.3
Industrial machinery and equipment	42.3	42.3	42.9	42.2
Electronic and other electrical equipment	41.6	41.8	42.2	41.3
Transportation equipment	44.0	43.7	44.3	43.2
Motor vehicles and equipment	45.0	44.6	45.5	44.2
Instruments and related products	41.2	41.2	41.6	41.2
Miscellaneous manufacturing	39.5	39.4	39.8	39.3
Nondurable goods	41.0	40.9	41.3	40.6
Overtime hours	4.5	4.3	4.6	4.3
Food and kindred products	41.6	41.6	41.9	41.2
Textile mill products	41.7	41.6	41.9	41.1
Apparel and other textile products	37.7	37.8	38.0	37.1
Paper and allied products	43.5	43.2	43.6	42.8
Printing and publishing	38.3	38.2	38.5	38.0
Chemicals and allied products	42.7	42.6	42.9	42.7
Rubber and miscellaneous plastics products	41.6	41.5	42.1	41.3
Leather and leather products	38.1	38.0	38.9	38.2
SERVICE-PRODUCING	32.8	32.8	32.8	32.7
TRANSPORTATION AND PUBLIC UTILITIES	38.3	38.3	38.7	38.4
WHOLESALE TRADE	38.5	38.6	38.6	38.6
RETAIL TRADE	29.1	29.0	28.8	28.8

2000

Industry	June	July (p)	Aug. (p)
PRIVATE SECTOR	34.5	34.4	34.3
GOODS-PRODUCING	40.9	41.1	40.8
MINING	44.7	45.2	44.6
MANUFACTURING	41.6	41.7	41.3
Overtime hours	4.6	46.0	4.5
Durable goods	42.2	42.5	41.9
Overtime hours	4.8	4.7	4.6
Lumber and wood products	40.8	41.1	40.4
Furniture and fixtures	39.9	40.0	39.5
Stone, clay, and glass products	42.9	43.7	43.2
Primary metal industries	43.9	44.2	43.5
Blast furnaces and basic steel products	45.0	45.0	44.2
Fabricated metal products	42.4	42.6	42.0
Industrial machinery and equipment	42.5	42.6	42.1
Electronic and other electrical equipment	41.4	41.9	41.1
Transportation equipment	44.0	43.9	43.5
Motor vehicles and equipment	45.3	44.4	44.7
Instruments and related products	41.3	41.8	41.1
Miscellaneous manufacturing	39.4	39.7	39.4
Nondurable goods	40.7	40.7	40.5
Overtime hours	4.3	4.3	4.2
Food and kindred products	41.5	41.2	41.5
Textile mill products	41.1	41.2	40.4
Apparel and other textile products	37.0	37.3	36.7
Paper and allied products	42.8	42.4	42.4
Printing and publishing	38.2	38.2	38.1
Chemicals and allied products	42.9	43.3	42.8
Rubber and miscellaneous plastics products	41.4	41.3	41.2
Leather and leather products	37.8	37.3	37.8
SERVICE-PRODUCING	32.9	32.7	32.7
TRANSPORTATION AND PUBLIC UTILITIES	38.4	38.8	38.2
WHOLESALE TRADE	38.6	38.5	38.2
RETAIL TRADE	29.0	28.8	28.9

(p) = preliminary.

NOTE: See "Notes on the data" for a description of the most recent benchmark revision.

14. Average hourly earnings of production or nonsupervisory workers

on private nonfarm payrolls, by industry, seasonally adjusted

Industry	Annual average 1998	Annual average 1999	1999 Aug.
PRIVATE SECTOR			
(In current dollars)	$12.78	$13.24	$13.30
Goods-producing	14.34	14.84	14.91
Mining	16.91	17.09	17.16
Construction	16.61	17.18	17.21
Manufacturing	13.49	13.91	14.01
Excluding overtime	12.79	13.18	13.27
Service-producing	12.27	12.73	12.78
Transportation and public utilities	15.31	15.69	15.73
Wholesale trade	14.07	14.58	14.65
Retail trade	8.74	9.08	9.13
Finance, insurance, **and** real estate	14.07	14.62	14.65
Services	12.84	13.36	13.42
PRIVATE SECTOR (in constant (1982) dollars)	7.75	7.86	7.87

Industry	1999 Sept.	1999 Oct.	1999 Nov.
PRIVATE SECTOR			
(In current dollars)	$13.35	$13.38	$13.41
Goods-producing	14.96	14.99	15.03
Mining	17.14	17.09	17.00
Construction	17.26	17.33	17.37
Manufacturing	14.04	14.06	14.07
Excluding overtime	13.29	13.31	13.33
Service-producing	12.83	12.86	12.89
Transportation and public utilities	15.79	15.79	15.84
Wholesale trade	14.70	14.75	14.76
Retail trade	9.16	9.18	9.21
Finance, insurance, **and** real estate	14.71	14.73	14.76
Services	13.46	13.51	13.53
PRIVATE SECTOR (in constant (1982) dollars)	7.86	7.87	7.87

Industry	1999 Dec.	2000 Jan.	2000 Feb.
PRIVATE SECTOR			
(In current dollars)	$13.44	$13.49	$13.54

Goods-producing	15.05	15.13	15.20
Mining	17.04	17.09	17.14
Construction	17.44	17.50	17.60
Manufacturing	14.10	14.15	14.21
Excluding overtime	13.36	13.41	13.45
Service-producing	12.93	12.97	13.01
Transportation and public utilities	15.94	15.92	16.00
Wholesale trade	14.83	14.90	14.89
Retail trade	9.25	9.26	9.32
Finance, insurance, **and** real estate	14.78	14.86	14.87
Services	13.57	13.61	13.66
PRIVATE SECTOR (in constant (1982) dollars)	7.87	7.88	7.87

Industry	2000		
	Mar.	Apr.	May
PRIVATE SECTOR (In current dollars)	$13.58	$13.64	$13.66
Goods-producing	15.25	15.30	15.29
Mining	17.27	17.26	17.25
Construction	17.67	17.78	17.75
Manufacturing	14.23	14.28	14.27
Excluding overtime	13.47	13.49	13.53
Service-producing	13.05	13.11	13.15
Transportation and public utilities	16.04	16.12	16.22
Wholesale trade	14.98	15.03	15.02
Retail trade	9.35	9.39	9.39
Finance, insurance, **and** real estate	14.95	14.98	15.01
Services	13.69	13.74	13.79
PRIVATE SECTOR (in constant (1982) dollars)	7.84	7.87	7.88

Industry	2000		
	June	July (p)	Aug. (p)
PRIVATE SECTOR(In current dollars)	$13.70	$13.76	$13.80
Goods-producing	15.34	15.41	15.46
Mining	17.24	17.24	17.15
Construction	17.77	17.91	17.95
Manufacturing	14.36	14.39	14.44
Excluding overtime	13.60	13.64	13.70
Service-producing	13.19	13.24	13.28

Transportation and public utilities	16.28	16.19	16.28
Wholesale trade	15.16	15.23	15.28
Retail trade	9.43	9.45	9.48
Finance, insurance, **and** real estate	15.05	15.04	15.11
Services	13.82	13.90	13.96
PRIVATE SECTOR (in constant (1982) dollars)	7.86	7.88	--

-- Data not available.

(p) = preliminary.

NOTE: See "Notes on the data" for a description of the most recent benchmark revision.

15. Average hourly earnings of production or nonsupervisory workers on private nonfarm payrolls, by industry

Industry	Annual average		1999
	1998	1999	Aug.
PRIVATE SECTOR	$12.78	$13.24	$13.20
MINING	16.91	17.09	17.05
CONSTRUCTION	16.61	17.18	17.31
MANUFACTURING	13.49	13.91	13.95
Durable goods	13.98	14.40	14.47
Lumber and wood products	11.10	11.47	11.54
Furniture and fixtures	10.90	11.23	11.28
Stone, clay, and glass products	13.59	13.87	13.94
Primary metal industries	15.48	15.83	15.98
Blast furnaces and basic steel products	18.42	18.81	18.93
Fabricated metal products	13.07	13.48	13.52
Industrial machinery and equipment	14.47	15.02	15.14
Electronic and other electrical equipment	13.10	13.46	13.52
Transportation equipment	17.51	18.04	18.17
Motor vehicles and equipment	17.84	18.41	18.53
Instruments and related products	13.81	14.17	14.28
Miscellaneous manufacturing	10.88	11.30	11.31
Nondurable goods	12.76	13.16	13.17
Food and kindred products	11.80	12.09	12.07
Tobacco products	18.56	19.07	20.86
Textile mill products	10.39	10.71	10.72
Apparel and other textile products	8.52	8.86	8.88
Paper and allied products	15.50	15.94	15.95
Printing and publishing	13.46	13.84	13.83
Chemicals and allied products	17.09	17.38	17.41
Petroleum and coal products	20.91	21.39	21.21
Rubber and miscellaneous plastics products	11.89	12.36	12.37

Leather and leather products	9.35	9.77	9.86
TRANSPORTATION AND PUBLIC UTILITIES	15.31	15.69	15.69
WHOLESALE TRADE	14.07	14.58	14.65
RETAIL TRADE	8.74	9.08	9.05
FINANCE, INSURANCE, **AND** REAL ESTATE	14.07	14.62	14.62
SERVICES	12.84	13.36	13.23

Industry	1999		
	Sept.	Oct.	Nov.
PRIVATE SECTOR	$13.38	$13.41	$13.43
MINING	17.13	17.05	17.01
CONSTRUCTION	17.46	17.64	17.42
MANUFACTURING	14.11	14.03	14.08
Durable goods	14.62	14.55	14.58
Lumber and wood products	11.56	11.60	11.60
Furniture and fixtures	11.33	11.33	11.36
Stone, clay, and glass products	14.10	14.00	14.04
Primary metal industries	16.18	16.01	16.12
Blast furnaces and basic steel products	18.99	18.90	19.11
Fabricated metal products	13.64	13.52	13.59
Industrial machinery and equipment	15.24	15.18	15.22
Electronic and other electrical equipment	13.64	13.60	13.61
Transportation equipment	18.50	18.41	18.39
Motor vehicles and equipment	18.96	18.85	18.80
Instruments and related products	14.29	14.36	14.34
Miscellaneous manufacturing	11.43	11.45	11.41
Nondurable goods	13.33	13.25	13.31
Food and kindred products	12.18	12.09	12.19
Tobacco products	18.90	17.82	18.02
Textile mill products	10.78	10.73	10.80
Apparel and other textile products	9.01	8.99	898.00
Paper and allied products	16.24	16.09	16.08
Printing and publishing	13.98	13.98	14.02
Chemicals and allied products	17.67	17.61	17.64
Petroleum and coal products	21.55	21.62	21.76
Rubber and miscellaneous plastics products	12.51	12.42	12.46
Leather and leather products	9.95	9.91	9.93
TRANSPORTATION AND			

PUBLIC UTILITIES	15.80	15.78	15.90
WHOLESALE TRADE	14.68	14.74	17.76
RETAIL TRADE	9.19	9.21	9.22
FINANCE, INSURANCE, **AND** REAL ESTATE	14.64	14.69	14.74
SERVICES	13.45	13.51	13.57

Industry	1999 Dec.	2000 Jan.	Feb.
PRIVATE SECTOR	$13.46	$13.58	$13.58
MINING	17.19	17.30	17.20
CONSTRUCTION	17.47	17.39	17.42
MANUFACTURING	14.20	14.19	14.19
Durable goods	14.73	14.72	14.73
Lumber and wood products	11.64	11.67	11.63
Furniture and fixtures	11.47	11.47	11.51
Stone, clay, and glass products	13.97	13.94	13.96
Primary metal industries	16.17	16.20	16.28
Blast furnaces and basic steel products	19.09	19.16	19.32
Fabricated metal products	13.72	13.71	13.67
Industrial machinery and equipment	15.36	15.39	15.40
Electronic and other electrical equipment	13.73	13.77	13.72
Transportation equipment	18.72	18.57	18.58
Motor vehicles and equipment	19.22	18.99	19.03
Instruments and related products	14.41	14.38	14.41
Miscellaneous manufacturing	11.54	11.52	11.53
Nondurable goods	13.39	13.37	13.36
Food and kindred products	12.28	12.23	12.23
Tobacco products	18.03	17.21	17.48
Textile mill products	10.84	10.84	10.85
Apparel and other textile products	9.04	9.03	9.03
Paper and allied products	16.12	16.02	15.99
Printing and publishing	14.12	14.10	14.13
Chemicals and allied products	17.67	17.70	17.67
Petroleum and coal products	21.76	21.62	22.03
Rubber and miscellaneous plastics products	12.57	12.61	12.57
Leather and leather products	10.01	10.08	9.96
TRANSPORTATION AND PUBLIC UTILITIES	15.96	15.98	16.05
WHOLESALE TRADE	14.85	14.99	14.91

RETAIL TRADE	9.26	9.33	9.35
FINANCE, INSURANCE, **AND** REAL ESTATE	14.76	14.99	14.93
SERVICES	13.65	13.78	13.77

Industry	2000		
	Mar.	Apr.	May
PRIVATE SECTOR	$13.59	$13.69	$13.64
MINING	17.28	17.29	17.19
CONSTRUCTION	17.54	17.66	17.71
MANUFACTURING	14.22	14.28	14.27
Durable goods	14.76	14.82	14.80
Lumber and wood products	11.62	11.73	11.74
Furniture and fixtures	11.59	11.64	11.69
Stone, clay, and glass products	14.03	14.23	14.28
Primary metal industries	16.34	16.51	16.40
Blast furnaces and basic steel products	19.49	19.72	19.46
Fabricated metal products	13.69	13.75	13.75
Industrial machinery and equipment	15.43	15.42	15.45
Electronic and other electrical equipment	13.70	13.70	13.65
Transportation equipment	18.70	18.82	18.79
Motor vehicles and equipment	19.17	19.36	19.35
Instruments and related products	14.40	14.40	14.44
Miscellaneous manufacturing	11.55	11.58	11.59
Nondurable goods	13.37	13.45	13.43
Food and kindred products	12.27	12.36	12.36
Tobacco products	19.10	19.71	20.40
Textile mill products	10.86	10.94	10.91
Apparel and other textile products	9.05	9.05	9.05
Paper and allied products	16.00	16.15	16.12
Printing and publishing	14.18	14.20	14.15
Chemicals and allied products	17.63	17.77	17.80
Petroleum and coal products	22.24	21.77	21.34
Rubber and miscellaneous plastics products	12.58	12.67	12.65
Leather and leather products	10.01	10.13	10.05
TRANSPORTATION AND PUBLIC UTILITIES	16.02	16.15	16.13
WHOLESALE TRADE	14.83	15.14	14.99
RETAIL TRADE	9.37	9.42	9.39

FINANCE, INSURANCE, **AND** REAL ESTATE	14.97	15.12	15.02
SERVICES	13.77	13.83	13.76

Industry	2000 June	July (p)	Aug. (p)
PRIVATE SECTOR	$13.62	$13.69	$13.68
MINING	17.09	17.14	17.04
CONSTRUCTION	17.74	17.96	18.06
MANUFACTURING	14.34	14.37	14.38
Durable goods	14.90	14.87	14.92
Lumber and wood products	11.82	11.85	11.83
Furniture and fixtures	11.73	11.81	11.81
Stone, clay, and glass products	14.36	14.42	14.40
Primary metal industries	16.52	16.69	16.59
Blast furnaces and basic steel products	19.62	19.82	19.59
Fabricated metal products	13.82	13.81	13.90
Industrial machinery and equipment	15.51	15.61	15.60
Electronic and other electrical equipment	13.72	13.81	13.81
Transportation equipment	19.01	18.65	18.87
Motor vehicles and equipment	19.62	19.07	19.31
Instruments and related products	14.49	14.71	14.71
Miscellaneous manufacturing	11.60	11.66	11.65
Nondurable goods	13.48	13.62	13.57
Food and kindred products	12.39	12.46	12.43
Tobacco products	20.87	21.12	20.78
Textile mill products	10.91	10.96	10.98
Apparel and other textile products	9.07	9.06	9.09
Paper and allied products	16.18	16.27	16.18
Printing and publishing	14.15	14.28	14.30
Chemicals and allied products	17.91	18.32	18.32
Petroleum and coal products	21.19	21.26	21.08
Rubber and miscellaneous plastics products	12.72	12.82	12.77
Leather and leather products	10.08	10.06	10.13
TRANSPORTATION AND PUBLIC UTILITIES	16.17	16.21	16.24
WHOLESALE TRADE	15.04	15.26	15.21
RETAIL TRADE	9.38	9.38	9.39
FINANCE, INSURANCE, **AND**			

REAL ESTATE	14.93	15.02	14.98
SERVICES	13.68	13.75	13.72

(p) = preliminary.

NOTE: See "Notes on the data" for a description of the most recent benchmark revision.

16. Average weekly earnings of production or nonsupervisory workers on private nonfarm payrolls, by industry

Industry	Annual average 1998	Annual average 1999	1999 Aug.
PRIVATE SECTOR			
Current dollars	$442.19	$456.78	$463.32
Seasonally adjusted		--	458.85
Constant (1982) dollars	268.32	271.25	274.15
MINING	742.35	748.54	758.73
CONSTRUCTION	646.13	671.74	692.40
MANUFACTURING			
Current dollars	562.53	580.05	583.11
Constant (1982) dollars	341.34	344.45	345.04
Durable goods	591.35	607.68	612.08
Lumber and wood products	456.21	472.56	482.37
Furniture and fixtures	441.45	452.57	459.10
Stone, clay, and glass products	591.17	603.35	614.75
Primary metal industries	684.22	699.69	704.72
Bast furnaces and basic steel products	821.53	842.69	849.96
Fabricated metal products	552.86	568.86	571.90
Industrial machinery and equipment	619.32	633.84	637.39
Electronic and other electrical equipment	542.34	557.24	562.39
Transportation equipment	759.93	790.15	794.03
Motor vehicles and equipment	776.04	828.45	828.29
Instruments and related products	570.35	588.06	591.19
Miscellaneous manufacturing	434.11	449.74	452.40
Nondurable goods	521.88	538.24	539.97
Food and kindred products	492.06	505.36	506.94
Tobacco products	710.85	762.80	836.49
Textile mill products	425.99	438.04	440.59
Apparel and other textile products	317.80	332.25	333.00
Paper and allied products	672.70	693.39	690.55
Printing and publishing	515.52	528.89	531.07
Chemicals and allied products	738.29	747.34	750.37
Petroleum and coal products	911.68	921.91	903.55
Rubber and miscellaneous plastics products	495.81	515.41	512.12
Leather and leather products	351.56	369.31	381.58

TRANSPORTATION AND PUBLIC UTILITIES	604.76	607.20	618.19
WHOLESALE TRADE	538.88	558.41	565.49
RETAIL TRADE	253.46	263.32	270.60
FINANCE, INSURANCE, **AND** REAL ESTATE	512.15	52.24	540.94
SERVICES	418.58	435.54	439.24

Industry		1999	
	Sept.	Oct.	Nov.
PRIVATE SECTOR			
Current dollars	$458.93	$463.99	$463.34
Seasonally adjusted	460.58	461.61	462.65
Constant (1982) dollars	269.96	272.45	271.91
MINING	758.86	758.73	758.65
CONSTRUCTION	673.96	701.60	688.09
MANUFACTURING			
Current dollars	588.39	589.26	594.18
Constant (1982) dollars	346.11	346.01	348.70
Durable goods	615.50	618.38	622.57
Lumber and wood products	472.80	480.24	480.24
Furniture and fixtures	456.87	458.87	458.94
Stone, clay, and glass products	620.40	616.00	620.57
Primary metal industries	716.77	709.24	720.56
Bast furnaces and basic steel products	852.65	848.61	865.68
Fabricated metal products	571.52	574.60	580.29
Industrial machinery and equipment	635.51	640.60	646.85
Electronic and other electrical equipment	563.33	568.48	572.98
Transportation equipment	812.15	810.04	811.00
Motor vehicles and equipment	860.78	852.02	849.76
Instruments and related products	587.32	594.50	600.85
Miscellaneous manufacturing	453.77	459.15	459.82
Nondurable goods	546.53	547.23	551.03
Food and kindred products	512.62	512.62	518.08
Tobacco products	754.11	753.79	774.86
Textile mill products	438.75	445.30	449.28
Apparel and other textile products	331.57	338.92	337.65
Paper and allied products	709.69	704.74	704.30
Printing and publishing	539.63	539.63	543.98
Chemicals and allied products	765.11	758.99	765.58

Petroleum and coal products	930.96	933.98	935.68
Rubber and miscellaneous plastics products	520.42	516.67	523.32
Leather and leather products	372.13	374.60	378.33
TRANSPORTATION AND PUBLIC UTILITIES	608.30	605.95	608.97
WHOLESALE TRADE	560.78	567.49	566.78
RETAIL TRADE	264.67	266.17	264.61
FINANCE, INSURANCE, **AND** REAL ESTATE	528.50	530.31	530.64
SERVICES	434.44	441.78	443.74

Industry	Dec.	2000 Jan.	Feb.
PRIVATE SECTOR			
Current dollars	$465.72	$467.15	$464.44
Seasonally adjusted	463.68	465.41	468.48
Constant (1982) dollars	273.31	273.51	270.50
MINING	763.24	766.39	758.52
CONSTRUCTION	677.84	664.04	674.15
MANUFACTURING			
Current dollars	603.50	590.30	588.89
Constant (1982) dollars	354.17	345.61	342.98
Durable goods	634.86	621.18	620.13
Lumber and wood products	480.73	474.97	469.85
Furniture and fixtures	471.42	459.95	458.10
Stone, clay, and glass products	604.90	591.06	591.90
Primary metal industries	732.50	722.52	722.83
Bast furnaces and basic steel products	878.14	867.95	875.20
Fabricated metal products	594.08	579.93	576.87
Industrial machinery and equipment	663.55	654.08	650.96
Electronic and other electrical equipment	582.15	572.83	569.38
Transportation equipment	838.66	811.51	815.66
Motor vehicles and equipment	887.96	850.75	856.35
Instruments and related products	612.43	595.33	595.13
Miscellaneous manufacturing	466.22	450.43	453.13
Nondurable goods	557.02	544.16	542.42
Food and kindred products	520.67	505.10	500.21
Tobacco products	793.32	672.91	685.22
Textile mill products	453.11	443.36	448.11
Apparel and other textile			

products	343.52	335.92	339.53
Paper and allied products	712.50	695.27	687.57
Printing and publishing	550.68	534.39	536.94
Chemicals and allied products	772.18	757.56	750.98
Petroleum and coal products	937.86	933.98	959.10
Rubber and miscellaneous plastics products	532.97	523.32	520.40
Leather and leather products	375.75	372.96	375.49
TRANSPORTATION AND PUBLIC UTILITIES	612.86	612.03	611.51
WHOLESALE TRADE	570.24	578.61	568.07
RETAIL TRADE	271.32	265.91	266.48
FINANCE, INSURANCE, **AND** REAL ESTATE	534.31	551.63	538.97
SERVICES	444.99	450.61	448.90

Industry	2000 Mar.	Apr.	May
PRIVATE SECTOR			
Current dollars	$464.78	$473.67	$467.85
Seasonally adjusted	468.51	471.94	469.90
Constant (1982) dollars	268.35	273.32	269.65
MINING	758.59	776.32	763.24
CONSTRUCTION	680.55	692.27	701.32
MANUFACTURING			
Current dollars	590.13	595.48	590.78
Constant (1982) dollars	340.72	343.61	340.51
Durable goods	622.87	628.37	623.08
Lumber and wood products	470.61	482.10	480.17
Furniture and fixtures	462.44	464.44	465.26
Stone, clay, and glass products	596.28	614.74	621.18
Primary metal industries	723.86	734.70	721.60
Bast furnaces and basic steel products	751.10	891.34	873.75
Fabricated metal products	577.72	583.00	581.63
Industrial machinery and equipment	654.23	655.35	653.54
Electronic and other electrical equipment	571.29	569.92	561.02
Transportation equipment	819.06	829.96	817.37
Motor vehicles and equipment	860.73	880.88	866.88
Instruments and related products	593.28	594.72	592.04
Miscellaneous manufacturing	456.23	456.25	454.33
Nondurable goods	548.82	548.76	543.92

Food and kindred products	501.84	506.76	506.76
Tobacco products	741.08	782.49	811.92
Textile mill products	450.69	456.20	448.40
Apparel and other textile products	342.09	341.19	336.66
Paper and allied products	686.40	696.07	686.71
Printing and publishing	540.26	542.44	533.46
Chemicals and allied products	749.28	757.00	756.50
Petroleum and coal products	969.66	966.59	919.75
Rubber and miscellaneous plastics products	520.81	528.34	523.71
Leather and leather products	378.38	388.99	384.92
TRANSPORTATION AND PUBLIC UTILITIES	608.76	626.62	616.17
WHOLESALE TRADE	566.51	588.95	575.62
RETAIL TRADE	267.98	272.24	270.43
FINANCE, INSURANCE, **AND** REAL ESTATE	537.42	554.90	539.22
SERVICES	447.53	453.62	445.82

Industry	2000 June	2000 July(p)	2000 Aug.(p)
PRIVATE SECTOR			
Current dollars	$471.25	$477.78	$474.70
Seasonally adjusted	472.65	473.34	473.34
Constant (1982) dollars	270.06	273.49	--
MINING	770.76	774.73	766.80
CONSTRUCTION	702.50	723.79	726.01
MANUFACTURING			
Current dollars	597.98	590.61	595.33
Constant (1982) dollars	342.68	338.07	--
Durable goods	630.27	318.59	625.15
Lumber and wood products	485.80	482.30	483.85
Furniture and fixtures	468.03	166.50	471.22
Stone, clay, and glass products	624.66	631.60	630.72
Primary metal industries	728.53	724.35	
Bast furnaces and basic steel products	882.90	885.95	863.92
Fabricated metal products	587.35	575.88	583.80
Industrial machinery and equipment	659.18	654.06	653.64
Electronic and other electrical equipment	569.38	567.59	567.59
Transportation equipment	836.44	781.44	815.18
Motor vehicles and equipment	888.79	799.03	853.50
Instruments and related			

products	596.99	606.05	603.11
Miscellaneous manufacturing	458.20	453.57	460.18
Nondurable goods	549.98	548.89	550.94
Food and kindred products	512.95	513.35	518.33
Tobacco products	836.89	834.24	837.43
Textile mill products	451.67	443.88	445.79
Apparel and other textile products	339.22	333.41	334.51
Paper and allied products	692.50	686.59	681.18
Printing and publishing	534.87	541.21	546.26
Chemicals and allied products	768.34	784.10	782.26
Petroleum and coal products	923.88	958.83	923.30
Rubber and miscellaneous plastics products	529.15	520.49	523.57
Leather and leather products	387.07	367.19	390.01
TRANSPORTATION AND PUBLIC UTILITIES	622.55	635.43	628.49
WHOLESALE TRADE	579.04	592.09	581.02
RETAIL TRADE	274.83	279.52	277.94
FINANCE, INSURANCE, **AND** REAL ESTATE	540.47	551.23	539.28
SERVICES	447.34	453.75	451.39

(p) = preliminary.

NOTE: See "Notes on the data" for a description of the most recent benchmark revision. Dash indicates data not available.

17. Diffusion indexes of employment change, seasonally adjusted
(In percent)

	Jan.	Feb.	Mar.	Apr.
	Private nonfarm payrolls, 356 industries			
Over 1-month span:				
1998	63.2	56.6	60.5	58.7
1999	54.1	58.8	53.9	59.6
2000	60.8	54.1	60.7	56.5
Over 3-month span:				
1998	64.3	66.6	63.2	66.3
1999	58.3	57.3	58.4	54.4
2000	61.0	62.6	61.9	57.4
Over 6-month span:				
1998	69.8	67.4	65.2	61.8
1999	60.0	58.0	57.6	58.6
2000	65.6	60.8	61.0	61.9
Over 12-month span:				
1998	69.7	67.3	67.3	65.9
1999	60.3	58.3	57.6	59.4
2000	65.0	63.5	--	--

Manufacturing payrolls, 139 industries

Over 1-month span:				
1998	57.9	50.7	53.6	50.7
1999	45.0	41.0	42.8	46.4
2000	52.2	47.8	51.1	51.1
Over 3-month span:				
1998	56.8	56.8	52.2	52.2
1999	36.7	37.1	37.1	34.5
2000	47.8	52.5	49.3	48.9
Over 6-month span:				
1998	60.1	54.3	50.4	39.9
1999	35.6	33.5	33.5	37.1
2000	51.4	47.5	50.4	52.5
Over 12-month span:				
1998	55.0	51.8	51.8	46.8
1999	37.4	32.4	31.7	35.3
2000	47.8	45.3	--	--

	May	June	July	Aug.
	Private nonfarm payrolls, 356 industries			
Over 1-month span:				
1998	58.3	59.7	53.9	58.1
1999	52.8	57.9	53.8	53.8
2000	45.9	56.2	52.1	52.1
Over 3-month span:				
1998	63.6	58.0	57.4	57.9
1999	57.3	58.8	58.1	60.7
2000	56.7	57.0	58.0	--
Over 6-month span:				
1998	62.9	61.4	59.0	58.4
1999	54.4	59.7	60.4	62.1
2000	59.7	--	--	--
Over 12-month span:				
1998	63.9	62.5	62.1	61.0
1999	59.6	60.5	61.0	62.6
2000	--	--	--	--
	Manufacturing payrolls, 139 industries			
Over 1-month span:				
1998	47.1	50.0	37.8	50.0
1999	40.3	46.4	54.7	38.1
2000	45.7	51.1	55.4	38.8
Over 3-month span:				
1998	48.6	41.4	39.2	40.3
1999	37.8	43.5	39.9	45.0
2000	--	--	--	--
Over 6-month span:				

1998	43.5	42.1	38.8	36.7
1999	32.7	38.8	41.0	45.7
2000	--	--	--	--
Over 12-month span:				
1998	40.6	39.9	37.8	38.1
1999	36.0	37.1	38.8	39.6
2000	--	--	--	--

	Sept.	Oct.	Nov.	Dec.
	Private nonfarm payrolls, 356 industries			
Over 1-month span:				
1998	56.2	53.8	59.0	57.4
1999	57.3	60.7	60.8	59.0
2000	--	--	--	--
Over 3-month span:				
1998	59.7	58.1	58.6	59.4
1999	59.6	63.5	64.3	63.1
2000	--	--	--	--
Over 6-month span:				
1998	57.4	59.7	59.3	59.1
1999	64.0	65.2	65.2	64.6
2000	--	--	--	--
Over 12-month span:				
1998	61.0	59.8	59.8	58.1
1999	62.6	62.9	62.5	63.2
2000	--	--	--	--
	Manufacturing payrolls, 139 industries			
Over 1-month span:				
1998	45.7	39.9	41.7	43.9
1999	46.4	51.8	51.4	50.4
2000	--	--	--	--
Over 3-month span:				
1998	43.2	37.1	36.7	40.6
1999	42.1	50.4	51.1	50.7
2000	--	--	--	--
Over 6-month span:				
1998	36.0	39.9	34.5	32.7
1999	48.2	43.2	48.6	51.1
2000	--	--	--	--
Over 12-month span:				
1998	37.1	36.0	34.2	33.5
1999	42.4	42.4	42.4	46.0
2000	--	--	--	--

-- Data not available,

NOTE: Figures are the percent of industries with employment increasing plus one-half of the industries with unchanged employment, where 50 percent indicates an equal balance between industries with increasing and decreasing employment. Data for the 2 most recent months shown in each span are preliminary. See the "Definitions" in this section. See "Notes on

the data" for a description of the most recent benchmark revision.

18. Annual data: Employment status of the population

(Numbers in thousands)

Employment status	1991	1992	1993
Civilian noninstitutional population	190,925	192,805	194,838
Civilian labor force	128,105	128,105	131,056
Labor force participation rate	66.2	66.6	66.3
Employed	117,718	118,492	118,492
Employment-population ratio	61.7	61.5	61.7
Agriculture	3,269	3,247	3,409
Nonagricultural industries	114,499	115,245	119,651
Unemployed	8,628	9,613	7,996
Unemployment rate	6.8	7.5	6.9
Not in the labor force	64,578	64,700	65,638

Employment status	1994	1995	1996
Civilian noninstitutional population	196,814	198,584	200,591
Civilian labor force	132,304	133,943	133,943
Labor force participation rate	66.6	66.6	66.8
Employed	123,060	124,900	126,708
Employment-population ratio	62.5	62.9	63.2
Agriculture	3,409	3,440	3,443
Nonagricultural industries	121,460	123,264	123,264
Unemployed	7,404	7,236	6,739
Unemployment rate	6.1	5.6	5.4
Not in the labor force	65,758	66,280	66,647

Employment status	1997	1998	1999
Civilian noninstitutional population	203,133	205,220	207,753
Civilian labor force	136,297	137,673	139,368
Labor force participation rate	67.1	67.1	67.1
Employed	129,558	131,463	133,488
Employment-population ratio	63.8	64.1	64.3
Agriculture	3,399	3,378	3,281
Nonagricultural industries	126,159	128,085	130,207
Unemployed	6,739	6,210	5,880
Unemployment rate	4.9	4.5	4.2
Not in the labor force	66,837	67,547	68,385

19. Annual data: Employment levels by industry

(In thousands)

Industry	1991	1992	1993
Total employment	108,249	108,601	110,713
Private sector	89,847	89,956	91,872
	23,745	23,231	23,352
Mining	689	635	610
Construction	4,650	4,492	4,668
Manufacturing	18,406	18	18,075
Service-producing	84,504	85	87,361

	5,755	5,718	5,811
Wholesale trade	6,081	5,997	5,981
Retail trade	19,284	19,356	19,773
	6,646	6,602	6,757
Services	28,336	29,052	30,197
Government	18,402	18,545	18,841
Federal	2,966	2,969	2,915
State	4,355	4,408	4,488
Local	11,081	11,267	11,438
Industry	1994	1995	1996
Total employment	114,163	117,191	119,608
Private sector	95,036	97,885	100,189
	23,908	24,265	24,493
Mining	601	581	580
Construction	4,986	5,160	5,418
Manufacturing	18,321	18,524	18,495
Service-producing	90,256	92,925	95,115
	5,984	6,132	6,253
Wholesale trade	6,162	6,378	6,482
Retail trade	20,507	21,187	21,597
	6,896	6,806	6,911
Services	31,579	33,117	34,454
Government	19,128	19,305	19,419
Federal	2,870	2,822	2,757
State	4,576	4,635	4,606
Local	11,682	11,849	12,056
Industry	1997	1998	1999
Total employment	122,690	125,865	128,786
Private sector	103,133	106,042	108,616
	24,962	25,414	25,482
Mining	596	590	535
Construction	5,691	6,020	6,404
Manufacturing	18,675	18,805	18,543
Service-producing	97,727	100,451	103,304
	6,408	6,611	6,826
Wholesale trade	6,648	6,800	6,924
Retail trade	21,966	22,295	22,788
	7,109	7,389	7,569
Services	36,040	37,533	39,027
Government	19,557	19,823	20,170
Federal	2,699	2,686	2,669
State	4,582	4,612	4,695
Local	12,276	12,525	12,806

NOTE: See "Notes on the data" for a description of the most recent benchmark revision.

20. Annual data: Average hours and earnings of production or nonsupervisory workers on nonfarm payrolls, by industry

Industry	1991	1992	1993
Private sector:			
Average weekly hours	34.3	34.4	34.5
Average hourly earnings (in dollars)	10.32	10.57	10.83
Average weekly earnings (in dollars)	353.98	363.61	373.64

Mining:			
Average weekly hours	44.4	43.9	44.3
Average hourly earnings (in dollars)	14.19	14.54	14.60
Average weekly earnings (in dollars)	63,004	63,831	64,678
Construction:			
Average weekly hours	38.1	38.0	38.5
Average hourly earnings (in dollars)	14.00	14.15	14.38
Average weekly earnings (in dollars)	53,340	537.70	553.63
Manufacturing:			
Average weekly hours	40.7	41.0	41.4
Average hourly earnings (in dollars)	11.18	11.46	11.74
Average weekly earnings (in dollars)	455.03	469.86	486.04
Transportation and public utilities:			
Average weekly hours	38.1	38.3	39.3
Average hourly earnings (in dollars)	13.20	13.43	13.55
Average weekly earnings (in dollars)	502.92	514.37	532.52
Wholesale trade:			
Average weekly hours	38.1	38.2	38.2
Average hourly earnings (in dollars)	11.15	11.39	11.74
Average weekly earnings (in dollars)	424.82	435.10	448.47
Retail trade:			
Average weekly hours	28.6	28.8	28.8
Average hourly earnings (in dollars)	6.94	7.12	7.29
Average weekly earnings (in dollars)	198.48	205.06	209.95
Finance, Insurance, and real estate:			
Average weekly hours	35.7	35.8	35.8
Average hourly earnings (in dollars)	10.39	10.82	11.35
Average weekly earnings (in dollars)	370.92	387.36	406.33
Services:			
Average weekly hours	32.4	32.5	32.5
Average hourly earnings (in dollars)	10.23	10.54	10.78
Average weekly earnings (in dollars)	331.45	342.55	350.35

Industry	1994	1995	1996
Private sector:			
Average weekly hours	34.7	34.5	34.4
Average hourly earnings (in dollars)	11.12	11.43	11.82
Average weekly earnings (in dollars)	385.86	39,434	406.61
Mining:			
Average weekly hours	44.8	44.7	45.3
Average hourly earnings (in dollars)	14.88	15.30	15.62
Average weekly earnings (in dollars)	66,662	683.91	707.59
Construction:			
Average weekly hours	38.9	36.9	39.0
Average hourly earnings (in dollars)	14.73	15.09	15.47
Average weekly earnings (in dollars)	573.00	58,700	60,333
Manufacturing:			
Average weekly hours	42.0	41.6	41.6
Average hourly earnings (in dollars)	12.07	12.37	12.77
Average weekly earnings (in dollars)	506.94	514.59	531.23

Transportation and public utilities:			
Average weekly hours	39.7	39.4	39.6
Average hourly earnings (in dollars)	13.78	14.13	14.45
Average weekly earnings (in dollars)	547.07	55,672	572.22
Wholesale trade:			
Average weekly hours	38.4	38.3	38.3
Average hourly earnings (in dollars)	12.06	12.43	12.87
Average weekly earnings (in dollars)	463.10	476.07	49,292
Retail trade:			
Average weekly hours	28.9	28.8	28.8
Average hourly earnings (in dollars)	749	769	799
Average weekly earnings (in dollars)	216.46	221.47	230.11
Finance, Insurance, **and** real estate:			
Average weekly hours	35.8	35.9	35.9
Average hourly earnings (in dollars)	11.83	12.32	12.80
Average weekly earnings (in dollars)	423.51	442.29	459.52
Services:			
Average weekly hours	32.5	32.4	32.4
Average hourly earnings (in dollars)	11.04	11.39	11.79
Average weekly earnings (in dollars)	358.80	369.04	382.00

Industry	1997	1998	1999
Private sector:			
Average weekly hours	34.6	34.6	34.5
Average hourly earnings (in dollars)	12.28	12.78	13.24
Average weekly earnings (in dollars)	424.89	442.19	456.78
Mining:			
Average weekly hours	45.4	43.9	43.8
Average hourly earnings (in dollars)	16.15	16.91	17.09
Average weekly earnings (in dollars)	73,321	74,235	748.54
Construction:			
Average weekly hours	39.0	38.9	39.1
Average hourly earnings (in dollars)	16.04	16.61	17.18
Average weekly earnings (in dollars)	625.56	64,613	67,174
Manufacturing:			
Average weekly hours	42.0	41.7	41.7
Average hourly earnings (in dollars)	13.17	13.49	13.91
Average weekly earnings (in dollars)	553.14	56,253	580.05
Transportation and public utilities:			
Average weekly hours	39.7	39.5	38.7
Average hourly earnings (in dollars)	14.92	1,531	15.69
Average weekly earnings (in dollars)	592.32	604.75	607.20
Wholesale trade:			
Average weekly hours	38.4	38.3	38.3
Average hourly earnings (in dollars)	13.45	14.07	14.58
Average weekly earnings (in dollars)	516.48	538.88	558.41
Retail trade:			
Average weekly hours	28.9	29.0	29.0
Average hourly earnings (in dollars)	8.33	8.74	9.08
Average weekly earnings (in dollars)	240.74	253.40	263.32

Finance, Insurance, **and** real estate:			
Average weekly hours	36.1	36.4	36.2
Average hourly earnings (in dollars)	13.34	14.07	14.62
Average weekly earnings (in dollars)	481.57	512.15	529.24
Services:			
Average weekly hours	32.6	32.6	32.6
Average hourly earnings (in dollars)	12.28	12.84	13.36
Average weekly earnings (in dollars)	400.33	418.58	435.54

21. Employment Cost Index, compensation,(1) by occupation and industry group

(June 1989 = 100)

Series	1998 June	Sept.	Dec.
Civilian workers(2)	137.4	139.0	139.8
Workers, by occupational group:			
White-collar workers	138.7	140.6	141.4
Professional specialty and technical	138.3	140.0	141.0
Executive, administrative, and managerial	139.7	141.7	141.8
Administrative support, including clerical	139.3	140.4	141.3
Blue-collar workers	134.3	135.3	136.1
Service occupations	137.9	139.4	140.0
Workers, by industry division:			
Goods-producing	136.3	137.2	137.9
Manufacturing	137.2	138.2	138.9
Service-producing	137.7	139.6	140.4
Services	139.0	140.8	141.7
Health services	138.5	139.1	139.1
Hospitals	138.2	139.4	140.2
Educational services	137.7	140.2	141.0
Public administration(3)	137.4	138.9	139.9
Nonmanufacturing	137.3	139.0	139.9
Private industry workers	137.5	139.0	139.8
Excluding sales occupations	137.5	138.8	139.4
Workers, by occupational group:			
White-collar workers	139.4	141.1	142.0
Excluding sales occupations	139.9	141.3	141.9
Professional specialty and technical occupations	140.1	141.6	142.6
Executive, administrative, and managerial occupations	140.0	141.9	141.8
Sales occupations	137.3	140.4	142.6
Administrative support occupations, including clerical.	139.6	140.6	141.4
Blue-collar workers	134.3	135.2	135.9
Precision production, craft, and repair occupations	134.4	135.4	136.8

Machine operators, assemblers, and inspectors	134.7	130.7	130.7
Transportation and material moving occupations	129.9	138.5	139.2
Handlers, equipment cleaners, helpers, and laborers	137.6	137.3	138.0
Service occupations	136.0	138.0	139.0
Production and nonsupervisory occupations(4)	136.6	137.1	137.8
Workers, by industry division:			
Goods-producing	136.2	137.1	137.8
Excluding sales occupations	135.6	136.5	137.2
White-collar occupations	138.8	139.7	140.2
Excluding sales occupations	137.4	138.3	138.8
Blue-collar occupations	134.6	135.5	136.3
Construction.	132.7	133.4	134.3
Manufacturing	137.2	138.2	138.9
White-collar occupations	139.1	140.1	140.5
Excluding sales occupations	137.3	138.3	138.7
Blue-collar occupations	135.9	138.8	137.7
Durables	137.4	138.5	139.2
Nondurables	136.7	139.6	138.2
Service-producing	137.8	139.6	140.5
Excluding sales occupations	138.5	140.0	140.6
White-collar occupations	139.3	141.2	142.2
Excluding sales occupations	140.6	142.2	142.8
Blue-collar occupations	133.2	134.3	134.8
Service occupations	135.8	137.0	137.8
Transportation and public utilities	137.1	138.5	139.3
Transportation	134.9	136.7	137.3
Public utilities	139.7	140.7	141.9
Communications	139.2	140.5	141.7
Electric, gas, and sanitary services	140.3	141.0	142.1
Wholesale and retail trade	135.8	137.6	138.2
Excluding sales occupations	136.3	138.1	138.8
Wholesale trade	138.6	140.8	142.8
Excluding sales occupations	138.2	140.0	141.2
Retail trade	134.4	135.9	135.6
General merchandise stores	133.0	133.2	134.0
Food stores	132.9	133.7	132.7
Finance, insurance, **and** real estate	138.4	141.0	142.5
Excluding sales occupations	141.3	143.2	143.3
Banking, savings and loan, and other credit agencies.	145.3	148.4	146.7
Insurance	138.9	141.9	141.7
Services	140.3	141.8	142.7
Business services	140.7	143.5	145.9
Health services	138.7	139.0	139.0
Hospitals	138.2	139.1	139.9
Educational services	143.9	147.0	147.7
Colleges and universities	144.8	147.8	148.5
Nonmanufacturing	137.2	138.9	139.7
White-collar workers	139.2	141.1	142.0

Excluding sales occupations	140.5	142.0	142.7
Blue-collar occupations	132.4	133.4	134.0
Service occupations	135.7	136.9	137.7
State and local government workers	136.9	139.0	139.8
Workers, by occupational group:			
White-collar workers	136.2	138.4	139.3
Professional specialty and technical	135.6	137.7	138.5
Executive, administrative, and managerial	137.9	140.4	141.6
Administrative support, including clerical	137.2	139.5	140.3
Blue-collar workers	135.2	136.8	137.8
Workers, by industry division:			
Services	136.6	139.0	139.7
Services excluding schools(5)	136.2	138.7	138.8
Health services	138.0	140.3	140.7
Hospitals	138.4	140.7	141.2
Educational services	136.5	138.8	139.6
Schools	136.7	139.1	139.9
Elementary and secondary	136.2	138.8	139.3
Colleges and universities	138.1	140.4	141.5
Public administration(3)	137.4	138.9	139.9

Series	1999 Mar.	1999 June	1999 Sept.
Civilian workers(2)	140.4	141.8	143.3
Workers, by occupational group:			
White-collar workers	141.9	143.3	145.0
Professional specialty and technical	141.3	142.2	143.9
Executive, administrative, and managerial	143.5	145.4	147.3
Administrative support, including clerical	142.5	143.4	144.7
Blue-collar workers	137.1	138.3	139.5
Service occupations	141.3	142.4	143.1
Workers, by industry division:			
Goods-producing	139.0	140.0	141.2
Manufacturing	139.9	140.9	142.1
Service-producing	140.9	142.4	144.0
Services	142.3	143.2	145.1
Health services	140.5	141.4	142.7
Hospitals	141.3	142.2	143.4
Educational services	141.3	141.7	144.6
Public administration(3)	140.8	141.5	142.4
Nonmanufacturing	140.5	141.9	143.4
Private industry workers	140.4	142.0	143.3

Excluding sales occupations	140.5	141.9	143.2
Workers, by occupational group:			
White-collar workers	142.4	144.1	145.6
Excluding sales occupations	143.0	144.5	146.0
Professional specialty and technical occupations	142.9	144.1	145.2
Executive, administrative, and managerial occupations	143.7	145.8	147.7
Sales occupations	139.6	142.6	144.1
Administrative support occupations, including clerical.	142.6	143.7	145.0
Blue-collar workers	136.9	138.2	139.4
Precision production, craft, and repair occupations	137.3	138.4	139.6
Machine operators, assemblers, and inspectors	131.6	138.4	139.9
Transportation and material moving occupations	141.0	133.6	134.4
Handlers, equipment cleaners, helpers, and laborers	139.5	142.3	143.2
Service occupations	139.3	140.6	141.0
Production and nonsupervisory occupations(4)	138.9	140.8	141.9
Workers, by industry division:			
Goods-producing	138.9	139.9	141.1
Excluding sales occupations	138.3	139.3	140.5
White-collar occupations	141.7	142.7	143.9
Excluding sales occupations	140.4	141.3	142.5
Blue-collar occupations	137.1	138.3	139.4
Construction.	135.6	136.9	137.9
Manufacturing	139.9	140.9	142.1
White-collar occupations	141.8	143.0	144.3
Excluding sales occupations	140.1	141.3	142.5
Blue-collar occupations	138.5	139.4	140.5
Durables	139.9	141.0	142.3
Nondurables	139.6	140.4	141.5
Service-producing	140.9	142.8	144.1
Excluding sales occupations	141.7	143.3	144.6
White-collar occupations	142.3	144.3	145.8
Excluding sales occupations	143.8	145.5	147.0
Blue-collar occupations	136.2	137.8	139.1
Service occupations	139.3	140.5	140.8
Transportation and public utilities	139.7	140.9	141.8
Transportation	136.8	138.1	138.7
Public utilities	143.4	144.6	145.7
Communications	143.3	144.9	146.1
Electric, gas, and sanitary services	143.4	144.2	145.1
Wholesale and retail trade	138.9	141.1	142.2
Excluding sales occupations	139.9	141.9	142.8
Wholesale trade	142.7	144.6	146.3
Excluding sales occupations	142.4	144.0	145.8
Retail trade	136.8	139.1	140.0
General merchandise stores	135.0	135.6	137.2
Food stores	134.3	135.7	137.0

Finance, insurance, **and** real estate	141.5	145.8	147.6
Excluding sales occupations	145.6	148.8	151.0
Banking, savings and loan, and other credit agencies.	148.8	155.4	159.3
Insurance	141.7	144.0	144.5
Services	143.5	144.6	146.1
Business services	147.5	148.7	150.7
Health services	140.5	141.4	142.6
Hospitals	141.2	142.1	143.0
Educational services	148.3	148.7	152.2
Colleges and universities	149.2	149.6	152.6
Nonmanufacturing	140.3	142.0	143.4
White-collar workers	142.3	144.1	145.6
Excluding sales occupations	143.7	145.3	146.8
Blue-collar occupations	135.2	136.8	138.0
Service occupations	139.2	140.4	140.7
State and local government workers	140.5	141.0	143.1
Workers, by occupational group:			
White-collar workers	139.8	140.2	142.6
Professional specialty and technical	138.8	139.3	142.0
Executive, administrative, and managerial	142.6	142.8	144.5
Administrative support, including clerical	141.4	141.3	143.0
Blue-collar workers	138.8	139.5	140.9
Workers, by industry division:			
Services	140.0	140.5	143.2
Services excluding schools(5)	139.6	140.3	142.6
Health services	141.2	142.0	144.2
Hospitals	141.7	142.7	144.8
Educational services	139.9	140.3	143.1
Schools	140.2	140.6	143.5
Elementary and secondary	139.6	140.0	142.9
Colleges and universities	141.7	142.1	144.8
Public administration(3)	140.8	141.5	142.4

Series	1999 Dec.	2000 Mar.	June
Civilian workers(2)	144.6	146.5	148.0
Workers, by occupational group:			
White-collar workers	146.3	148.4	149. 9
Professional specialty and technical	145.3	146.7	148.3
Executive, administrative, and managerial	148.6	150.5	151.9
Administrative support,			

including clerical	146.1	148.6	150.1
Blue-collar workers	140.6	142.7	144.1
Service occupations	144.8	146.0	147.1
Workers, by industry division:			
Goods-producing	142.5	144.9	146.6
Manufacturing	143.6	146.0	147.5
Service-producing	145.3	147.1	148.4
Services	146.5	148.0	149.3
Health services	144.3	145.9	147.5
Hospitals	145.0	146.3	147.7
Educational services	145.8	146.5	146.8
Public administration(3)	144.4	145.7	146.1
Nonmanufacturing	144.7	146.6	148.0
Private industry workers	144.6	146.8	148.5
Excluding sales occupations	144.5	146.5	148.2
Workers, by occupational group:			
White-collar workers	146.9	149.3	151.1
Excluding sales occupations	147.3	149.4	151.3
Professional specialty and technical occupations	146.7	148.4	150.7
Executive, administrative, and managerial occupations	149.1	151.1	152.7
Sales occupations	145.3	148.9	150.3
Administrative support occupations, including clerical.	146.2	149.0	150.6
Blue-collar workers	140.5	142.6	144.1
Precision production, craft, and repair occupations	140.6	142.3	144.1
Machine operators, assemblers, and inspectors	141.4	144.0	145.0
Transportation and material moving occupations	135.2	137.5	138.6
Handlers, equipment cleaners, helpers, and laborers	144.4	146.4	148.1
Service occupations	142.6	143.9	145.4
Production and nonsupervisory occupations(4)	143.1	145.3	146.9
Workers, by industry division:			
Goods-producing	142.5	144.8	146.6
Excluding sales occupations	141.8	144.2	145.9
White-collar occupations	145.5	148.1	150.1
Excluding sales occupations	143.9	146.5	148.4
Blue-collar occupations	140.7	142.8	144.4
Construction.	138.7	140.8	143.2
Manufacturing	143.6	146.0	147.5
White-collar occupations	145.8	148.2	150.2
Excluding sales occupations	143.8	146.2	148.2
Blue-collar occupations	142.1	144.4	145.6
Durables	144.0	146.5	148.3
Nondurables	142.8	144.9	146.0
Service-producing	145.3	147.4	149.1
Excluding sales occupations	145.9	147.7	149.4

White-collar occupations	147.0	149.3	151.0
Excluding sales occupations	148.3	150.3	152.1
Blue-collar occupations	139.8	141.8	143.1
Service occupations	142.4	143.6	145.1
Transportation and public utilities	142.3	143.9	145.7
Transportation	139.5	140.4	141.8
Public utilities	146.1	148.6	150.9
Communications	146.0	148.4	150.9
Electric, gas, and sanitary services	146.1	148.9	151.0
Wholesale and retail trade	143.5	145.6	147.3
Excluding sales occupations	144.3	146.4	148.1
Wholesale trade	148.5	150.0	151.8
Excluding sales occupations	147.4	149.6	151.1
Retail trade	140.7	143.2	144.8
General merchandise stores	138.3	139.7	141.0
Food stores	138.1	140.1	142.5
Finance, insurance, **and** real estate	148.3	152.0	153.1
Excluding sales occupations	151.6	154.2	155.5
Banking, savings and loan, and other credit agencies.	159.8	162.7	164.2
Insurance	145.8	149.9	151.3
Services	147.6	149.4	151.2
Business services	151.9	154.2	156.3
Health services	144.2	145.8	147.5
Hospitals	144.6	145.8	147.5
Educational services	153.0	154.0	154.9
Colleges and universities	153.3	154.6	155.5
Nonmanufacturing	144.5	146.7	148.4
White-collar workers	146.9	149.2	151.0
Excluding sales occupations	148.1	150.2	152.0
Blue-collar occupations	138.7	140.6	142.3
Service occupations	142.3	143.5	145.1
State and local government workers	144.6	145.5	145.9
Workers, by occupational group:			
White-collar workers	144.0	144.9	145.3
Professional specialty and technical	143.2	144.1	144.5
Executive, administrative, and managerial	146.1	147.0	147.2
Administrative support, including clerical	145.0	145.9	146.5
Blue-collar workers	142.5	143.7	144.2
Workers, by industry division:			
Services	144.5	145.2	145.5
Services excluding schools(5)	143.8	145.2	145.8
Health services	145.8	147.3	147.9
Hospitals	146.3	147.9	148.4
Educational services	144.4	145.0	145.2
Schools	144.7	145.3	145.5
Elementary and secondary	144.1	144.5	144.7
Colleges and universities	146.5	147.4	147.6

Series			
Public administration(3)	144.4	145.7	146.1

Series	Percent change: 3 months ended June 2000	Percent change: 12 months ended June 2000
Civilian workers(2)	1.0	4.4
Workers, by occupational group:		
White-collar workers	1.0	4.6
Professional specialty and technical	1.1	4.3
Executive, administrative, and managerial	.9	4.5
Administrative support, including clerical	1.0	4.7
Blue-collar workers	1.0	4.2
Service occupations	.8	3.3
Workers, by industry division:		
Goods-producing	1.2	4.7
Manufacturing	1.0	4.7
Service-producing	.9	4.2
Services	.9	4.3
Health services	1.1	4.3
Hospitals	1.0	3.9
Educational services	.2	3.6
Public administration(3)	.3	3.3
Nonmanufacturing	1.0	4.3
Private industry workers	1.2	4.6
Excluding sales occupations	1.2	4.4
Workers, by occupational group:		
White-collar workers	1.2	4.9
Excluding sales occupations	1.3	4.7
Professional specialty and technical occupations	1.5	4.6
Executive, administrative, and managerial occupations	1.1	4.7
Sales occupations	.9	5.4
Administrative support occupations, including clerical.	1.1	4.8
Blue-collar workers	1.1	4.3
Precision production, craft, and repair occupations	1.3	4.1
Machine operators, assemblers, and inspectors	.7	4.8
Transportation and material moving occupations	.8	3.7
Handlers, equipment cleaners, helpers, and laborers	1.2	4.1

Service occupations	1.0	3.4
Production and nonsupervisory occupations(4)	1.1	4.3
Workers, by industry division:		
Goods-producing	1.2	4.8
Excluding sales occupations	1.2	4.7
White-collar occupations	1.4	5.2
Excluding sales occupations	1.3	5.0
Blue-collar occupations	1.1	4.4
Construction.	1.7	4.6
Manufacturing	1.0	4.7
White-collar occupations	1.3	5.0
Excluding sales occupations	1.4	4.9
Blue-collar occupations	.8	4.4
Durables	1.2	5.2
Nondurables	.8	4.0
Service-producing	1.2	4.4
Excluding sales occupations	1.2	4.3
White-collar occupations	1.1	4.6
Excluding sales occupations	1.2	4.5
Blue-collar occupations	.9	3.8
Service occupations	1.0	3.3
Transportation and public utilities	1.3	3.4
Transportation	1.0	2.7
Public utilities	1.5	4.4
Communications	1.7	4.1
Electric, gas, and sanitary services	1.4	4.7
Wholesale and retail trade	1.2	4.4
Excluding sales occupations	1.2	4.4
Wholesale trade	1.2	5.0
Excluding sales occupations	1.0	4.9
Retail trade	1.2	4.1
General merchandise stores	.9	4.0
Food stores	1.7	5.0
Finance, insurance, **and** real estate	.7	5.0
Excluding sales occupations	.8	4.5
Banking, savings and loan, and other credit agencies.	.9	5.7
Insurance	.9	5.1
Services	1.2	4.6
Business services	1.4	5.1
Health services	1.2	4.3
Hospitals	1.2	3.8
Educational services	.6	4.2
Colleges and universities	.6	3.9
Nonmanufacturing	1.2	4.5
White-collar workers	1.2	4.8
Excluding sales occupations	1.2	4.6
Blue-collar occupations	1.2	4.0
Service occupations	1.1	3.3
State and local government workers	.3	3.5
Workers, by occupational group:		

White-collar workers	.3	3.6
Professional specialty and technical	.3	3.7
Executive, administrative, and managerial	.1	3.1
Administrative support, including clerical	.4	3.7
Blue-collar workers	.3	3.4
Workers, by industry division:		
Services	.2	3.6
Services excluding schools(5)	.4	3.9
Health services	.4	4.2
Hospitals	.3	4.0
Educational services	.1	3.5
Schools	.1	3.5
Elementary and secondary	.1	3.4
Colleges and universities	.1	3.9
Public administration(3)	.3	3.3

(1) Cost (cents per hour worked) measured in the Employment Cost Index consists of wages, salaries, and employer cost of employee benefits.

(2) Consists of private industry workers (excluding farm and household workers) and State and local government (excluding Federal Government) workers.

(3) Consists of legislative, judicial, administrative, and regulatory activities.

(4) This series has the same industry and occupational coverage as the Hourly Earnings index, which was discontinued in January 1989.

(5) Includes, for example, library, social, and health services.

22. Employment Cost Index, wages and salaries, by occupation and Industry group

(June 1989 = 100)

Series	1998 June	1998 Sept.	1998 Dec.
Civilian workers(1)	135.0	136.8	137.7
Workers, by occupational group:			
White-collar workers	136.7	138.8	137.7
Professional specialty and technical	136.6	138.5	139.4
Executive, adminitrative, and managerial	138.3	140.5	140.3
Administrative support, including clerical	136.2	137.5	138.6
Blue-collar workers	131.4	132.6	133.3
Service occupations	134.5	136.1	137.0
Workers, by industry division:			
Goods-producing	133.3	134.4	135.2
Manufacturing	134.6	136.0	136.8
Service-producing	135.7	137.8	136.7
Services	137.6	137.6	140.5
Health services	136.5	137.6	137.6
Hospitals	135.1	136.4	137.1
Educational services	136.5	139.1	140.0
Public administration(2)	133.2	134.8	135.9
Nonmanufacturing	135.1	137.0	137.8

Private Industry workers	134.9	136.6	137.4
Excluding sales occupations	134.8	136.3	136.9
Workers, by occupational group:			
White-collar workers	137.0	139.0	139.9
Excluding sales occupations	137.5	139.1	139.7
Professional specialty and technical occupations	137.1	138.7	139.7
Executive, adminitrative, and managerial occupations	138.7	140.9	140.5
Sales occupations	135.2	138.8	141.3
Administrative support occupations, including clerical	136.7	137.9	138.9
Blue-collar workers	131.3	132.4	133.2
Precision production, craft, and repair occupations	131.2	132.3	133.0
Machine operators, assemblers, and inspectors	132.7	133.8	134.9
Transportation and material moving occupations	126.4	127.6	127.8
Handlers, equipment cleaners, helpers, and laborers	133.7	135.1	133.8
Service occupations	133.0	134.4	135.3
Production and nonsupervisory occupations(3)	133.6	135.2	136.4
Workers, and industry division:			
Goods-producing	133.2	134.3	135.2
Excluding sales occupations	132.5	133.6	134.4
White-collar occupations	136.3	137.4	138.2
Excluding sales occupations	134.6	135.7	136.4
Blue-collar occupations	131.3	132.3	133.3
Construction	128.1	128.5	129.3
Manufacturing	134.6	136.0	136.8
White-collar occupations	136.8	138.3	139.0
Excluding sales occupations	135.0	136.3	137.1
Blue-collar occupations	133.1	134.3	135.3
Durables	134.5	135.9	136.9
Nondurables	134.9	136.0	136.8
Service-producing	135.6	137.6	138.4
Excluding sales occupations	136.2	137.9	138.5
White-collar occupations	137.0	139.2	140.1
Excluding sales occupations	138.4	140.2	140.7
Blue-collar occupations	131.1	132.4	132.9
Service occupations	133.0	134.2	135.2
Transportation and public utilities	132.8	134.3	135.1
Transportation	130.4	132.4	132.9
Public utilities	135.7	136.5	137.8
Communications	135.8	136.7	138.0
Electric, gas, and sanitary services	135.6	136.3	137.4
Wholesale and retail trade	134.6	136.6	137.0

Excluding sales occupations	135.6	137.6	138.2
Wholesale trade	137.1	139.3	141.3
Excluding sales occupations	137.8	139.6	140.8
Retail trade	133.3	135.2	134.8
General merchandise stores	131.5	132.2	133.0
Food stores	130.5	131.7	130.5
Finance, insurance, and **real** estate	134.8	138.1	139.8
Excluding sales occupations	137.5	139.7	139.6
Banking, savings and loan, and other credit agencies	143.2	147.0	144.4
Insurance	134.8	138.7	138.5
Services	138.3	140.0	140.8
Business services	139.2	141.8	144.1
Health services	136.5	137.5	137.4
Hospitals	134.7	135.8	136.5
Educational services	139.6	142.8	143.5
Colleges and universities	139.7	142.8	143.6
Nonmanufacturing	134.7	136.5	137.4
White-collar workers	136.8	138.9	139.8
Excluding sales occupations	138.1	139.8	140.3
Blue-collar occupations	129.5	130.5	131.1
Service occupations	132.9	134.1	135.1
State and local government workers	135.4	137.6	138.5
Workers, by occupational group:			
White-collar workers	135.2	137.6	138.5
Professional specialty and technical	135.6	137.9	138.7
Executive, administrative, and managerial	135.6	138.0	139.3
Administrative support, including clerical	133.3	135.4	136.5
Blue-collar workers	133.5	135.1	136.0
Workers, by industry division:			
Services	135.9	138.4	139.2
Services excluding schools(4)	135.5	137.8	138.2
Health services	136.5	138.7	139.2
Hospitals	136.5	138.6	139.1
Educational services	135.8	138.4	139.3
Schools	136.0	138.5	139.5
Elementary and secondary	136.1	138.7	139.3
Colleges and universities	135.5	137.7	139.6
Public administration(2)	133.2	134.8	135.9

Series	1999 Mar.	June	Sept.
Civilian workers(1)	138.4	139.8	141.3
Workers, by occupational group:			
White-collar workers	140.1	141.6	143.3
Professional specialty and technical	140.1	141.0	142.6
Executive, adminitrative, and managerial	141.6	143.8	145.9
Administrative support,			

including clerical	140.0	140.9	142.3
Blue-collar workers	134.5	135.8	137.0
Service occupations	138.3	139.4	140.1
Workers, by industry division:			
Goods-producing	136.3	137.4	138.6
Manufacturing	137.9	139.0	140.2
Service-producing	139.2	140.7	142.3
Services	141.5	142.3	144.1
Health services	138.8	139.7	140.9
Hospitals	138.1	136.8	140.1
Educational services	140.2	140.6	143.7
Public administration(2)	136.9	137.8	139.5
Nonmanufacturing	138.4	139.9	141.5
Private Industry workers	138.1	139.7	141.0
Excluding sales occupations	138.2	139.6	140.8
Workers, by occupational group:			
White-collar workers	140.3	142.1	143.5
Excluding sales occupations	141.0	142.5	143.9
Professional specialty and technical occupations	140.7	141.8	142.6
Executive, adminitrative, and managerial occupations	147.6	149.2	146.4
Sales occupations	137.3	140.5	142.1
Administrative support occupations, including clerical	140.4	141.4	142.7
Blue-collar workers	134.3	135.6	136.8
Precision production, craft, and repair occupations	134.3	135.6	1367.0
Machine operators, assemblers, and inspectors	135.7	136.7	138.3
Transportation and material moving occupations	129.1	131.0	131.9
Handlers, equipment cleaners, helpers, and laborers	137.3	136.3	139.4
Service occupations	136.7	137.8	138.0
Production and nonsupervisory occupations(3)	136.8	138.2	139.3
Workers, and industry division:			
Goods-producing	136.3	137.3	136.5
Excluding sales occupations	135.5	136.6	137.8
White-collar occupations	139.4	140.5	141.7
Excluding sales occupations	137.8	136.8	140.1
Blue-collar occupations	134.3	135.4	136.6
Construction	130.7	131.9	133.0
Manufacturing	137.9	139.0	140.2
White-collar occupations	140.1	141.4	142.7
Excluding sales occupations	138.3	139.6	140.8
Blue-collar occupations	136.3	137.2	136.4
Durables	137.9	139.1	140.4
Nondurables	138.0	136.7	139.7
Service-producing	136.9	140.8	142.1
Excluding sales occupations	139.8	141.4	142.6
White-collar occupations	140.3	142.3	143.8

Excluding sales occupations	142.0	143.7	145.1
Blue-collar occupations	134.4	135.9	137.0
Service occupations	136.7	137.8	138.0
Transportation and public utilities	135.4	135.8	137.5
Transportation	132.3	133.7	134.4
Public utilities	139.2	140.6	141.5
Communications	139.4	141.1	141.9
Electric, gas, and sanitary services	138.9	140.0	140.9
Wholesale and retail trade	137.7	139.6	140.7
Excluding sales occupations	139.5	141.1	141.8
Wholesale trade	140.7	142.3	144.3
Excluding sales occupations	141.9	143.0	144.8
Retail trade	136.2	136.3	133.9
General merchandise stores	133.7	134.3	135.6
Food stores	131.8	132.8	133.9
Finance, insurance, and **real** estate	137.2	142.4	144.5
Excluding sales occupations	141.0	144.8	147.5
Banking, savings and loan, and other credit agencies	146.1	154.5	159.2
Insurance	137.4	139.8	140.2
Services	142.2	143.2	144.5
Business services	145.4	146.3	148.5
Health services	138.7	139.6	140.6
Hospitals	137.6	138.3	139.3
Educational services	143.9	144.2	147.5
Colleges and universities	144.1	144.4	147.2
Nonmanufacturing	137.9	139.7	141.0
White-collar workers	140.1	142.0	143.5
Excluding sales occupations	141.6	143.2	144.6
Blue-collar occupations	132.4	134.0	135.1
Service occupations	136.5	137.7	137.9
State and local government workers	139.0	139.6	142.2
Workers, by occupational group:			
White-collar workers	138.9	139.3	142.1
Professional specialty and technical	138.9	139.4	142.5
Executive, administrative, and managerial	140.1	140.5	142.7
Administrative support, including clerical	137.4	137.5	139.6
Blue-collar workers	136.9	137.6	139.4
Workers, by industry division:			
Services	139.5	139.9	142.9
Services excluding schools(4)	139.0	139.6	142.1
Health services	139.7	140.4	142.8
Hospitals	139.7	140.6	142.8
Educational services	139.5	139.8	142.9
Schools	139.6	140.0	143.1
Elementary and secondary	139.5	139.9	143.1
Colleges and universities	139.6	139.8	142.6
Public administration(2)	136.9	137.8	139.5

1999 2000

Series	Dec.	Mar.	June
Civilian workers(1)	142.5	144.0	145.4
Workers, by occupational group:			
White-collar workers	144.6	146.2	147.6
Professional specialty and technical	144.0	144.9	146.4
Executive, adminitrative, and managerial	147.2	148.6	149.9
Administrative support, including clerical	143.5	145.5	146.9
Blue-collar workers	137.9	139.2	140.6
Service occupations	141.7	143.0	144.0
Workers, by industry division:			
Goods-producing	139.7	141.3	143.0
Manufacturing	141.5	142.9	144.4
Service-producing	143.5	145.0	146.3
Services	145.5	146.6	147.9
Health services	142.5	143.8	145.3
Hospitals	141.6	142.6	143.8
Educational services	144.7	145.3	145.6
Public administration(2)	141.5	142.5	142.9
Nonmanufacturing	142.6	144.2	145.5
Private Industry workers	142.2	143.9	145.4
Excluding sales occupations	142.0	143.5	145.1
Workers, by occupational group:			
White-collar workers	144.8	146.6	148.3
Excluding sales occupations	145.2	146.7	148.5
Professional specialty and technical occupations	144.1	145.1	147.3
Executive, adminitrative, and managerial occupations	147.6	149.2	150.7
Sales occupations	143.3	146.7	147.9
Administrative support occupations, including clerical	143.8	146.0	147.5
Blue-collar workers	137.7	139.1	140.5
Precision production, craft, and repair occupations	137.5	138.9	140.6
Machine operators, assemblers, and inspectors	139.5	140.7	141.6
Transportation and material moving occupations	132.7	134.1	135.2
Handlers, equipment cleaners, helpers, and laborers	140.4	141.8	143.6
Service occupations	139.6	141.0	142.5
Production and nonsupervisory occupations(3)	140.4	142.1	143.7
Workers, and industry division:			
Goods-producing	139.7	141.3	143.0
Excluding sales occupations	136.9	140.5	142.1

White-collar occupations	143.0	145.0	146.8
Excluding sales occupations	141.3	143.2	144.9
Blue-collar occupations	137.6	139.0	140.5
Construction	133.6	136.0	136.0
Manufacturing	141.5	142.9	144.4
White-collar occupations	144.0	145.8	147.7
Excluding sales occupations	142.0	143.7	145.6
Blue-collar occupations	138.4	140.8	142.0
Durables	141.8	143.0	144.7
Nondurables	140.9	142.7	143.9
Service-producing	143.3	145.0	146.5
Excluding sales occupations	143.8	145.3	146.9
White-collar occupations	145.0	146.9	148.5
Excluding sales occupations	146.4	147.8	149.6
Blue-collar occupations	137.8	139.1	140.3
Service occupations	139.6	141.1	142.5
Transportation and public utilities	137.9	138	
Transportation	134.9	134.9	136.2
Public utilities	141.8	143.2	144.9
Communications	142.2	143.4	145.0
Electric, gas, and sanitary services	141.3	143.0	144.7
Wholesale and retail trade	142.0	143.8	145.5
Excluding sales occupations	143.3	145.2	146.8
Wholesale trade	146.5	147.4	149.4
Excluding sales occupations	146.4	147.9	149.7
Retail trade	139.6	142.1	143.5
General merchandise stores	136.7	137.8	138.5
Food stores	134.9	136.7	139.5
Finance, insurance, and **real** estate	145.2	148.7	149.5
Excluding sales occupations	148.0	150.2	151.5
Banking, savings and loan, and other credit agencies	159.6	162.0	163.3
Insurance	141.5	145.5	146.6
Services	146.0	147.4	149.1
Business services	149.8	152.0	154.1
Health services	142.2	143.5	145.3
Hospitals	140.9	141.8	143.3
Educational services	148.2	148.9	149.6
Colleges and universities	147.9	148.9	149.4
Nonmanufacturing	142.1	143.9	145.5
White-collar workers	144.7	146.5	148.2
Excluding sales occupations	145.9	147.4	149.1
Blue-collar occupations	135.8	137.4	138.9
Service occupations	139.5	140.9	142.4
State and local government workers	143.5	144.3	144.7
Workers, by occupational group:			
White-collar workers	143.4	144.1	144.5
Professional specialty and technical	143.6	144.3	144.7
Executive, administrative, and managerial	144.3	144.9	145.1
Administrative support, including clerical	141.7	142.4	143.0
Blue-collar workers	140.7	141.5	142.1

Workers, by industry division:			
Services	144.0	144.6	144.9
Services excluding schools(4)	143.2	144.3	144.8
Health services	144.2	145.3	145.7
Hospitals	144.1	145.3	145.6
Educational services	144.0	144.5	144.8
Schools	144.2	144.7	144.9
Elementary and secondary	144.1	144.5	144. 6
Colleges and universities	144.4	144.9	145.6
Public administration(2)	141.5	142.5	142.9

Series	Percent change 3 months ended June 2000	Percent change 12 months ended June 2000
Civilian workers(1)	1.0	4.0
Workers, by occupational group:		
White-collar workers	1.0	4.2
Professional specialty and technical	1.0	3.8
Executive, adminitrative, and managerial	0.9	4.2
Administrative support, including clerical	1.0	4.3
Blue-collar workers	1.0	3.5
Service occupations	0.7	3.5
Workers, by industry division:		
Goods-producing	1.2	4.1
Manufacturing	1.0	3.9
Service-producing	0.9	4.0
Services	0.9	3.9
Health services	1.0	4.0
Hospitals	0.8	3.6
Educational services	0.2	3.6
Public administration(2)	0.3	3.7
Nonmanufacturing	0.9	3.7
Private Industry workers	1.0	4.0
Excluding sales occupations	1.1	3.9
Workers, by occupational group:		
White-collar workers	1.2	4.4
Excluding sales occupations	1.2	4.2
Professional specialty and technical occupations	1.5	3.9
Executive, adminitrative, and managerial occupations	1.0	4.4
Sales occupations	0.8	5.3
Administrative support occupations, including clerical	1.0	4.3
Blue-collar workers	1.0	3.6
Precision production, craft, and repair occupations	1.2	3.7

Machine operators, assemblers, and inspectors	0.6	3.6
Transportation and material moving occupations	0.8	3.2
Handlers, equipment cleaners, helpers, and laborers	1.3	3.8
Service occupations	1.1	3.4
Production and nonsupervisory occupations(3)	1.1	4.0
Workers, and industry division:		
Goods-producing	1.2	4.2
Excluding sales occupations	1.1	4.0
White-collar occupations	1.2	4.5
Excluding sales occupations	1.2	4.4
Blue-collar occupations	1.1	3.8
Construction	1.5	4.6
Manufacturing	1.0	3.9
White-collar occupations	1.3	4.5
Excluding sales occupations	1.3	4.3
Blue-collar occupations	0.9	3.5
Durables	1.2	4.0
Nondurables	0.8	3.7
Service-producing	1.0	4.0
Excluding sales occupations	1.1	3.9
White-collar occupations	1.1	4.4
Excluding sales occupations	1.2	4.1
Blue-collar occupations	0.9	3.2
Service occupations	1.0	3.4
Transportation and public utilities	1.1	2.3
Transportation	1.0	1.9
Public utilities	1.2	3.1
Communications	1.1	2.8
Electric, gas, and sanitary services	1.0	3.4
Wholesale and retail trade	1.2	4.2
Excluding sales occupations	1.1	4.0
Wholesale trade	1.4	5.0
Excluding sales occupations	1.2	4.7
Retail trade	1.0	3.8
General merchandise stores	0.5	3.1
Food stores	2.0	5.0
Finance, insurance, and **real** estate	0.5	5.0
Excluding sales occupations	0.9	4.6
Banking, savings and loan, and other credit agencies	0.8	5.7
Insurance	0.8	4.9
Services	1.2	4.1
Business services	1.4	5.3
Health services	1.3	4.1
Hospitals	1.1	3.6
Educational services	0.5	3.7
Colleges and universities	0.3	3.5
Nonmanufacturing	1.1	4.2
White-collar workers	1.2	4.4
Excluding sales occupations	1.2	4.1
Blue-collar occupations	1.1	3.7

Service occupations	1.1	3.4
State and local government workers	0.3	3.7
Workers, by occupational group:		
White-collar workers	0.3	3.7
Professional specialty and technical	0.3	3.8
Executive, administrative, and managerial	0.1	3.3
Administrative support, including clerical	0.4	4.0
Blue-collar workers	0.4	3.3
Workers, by industry division:		
Services	0.2	3.6
Services excluding schools(4)	0.3	3.7
Health services	0.3	3.8
Hospitals	0.2	3.6
Educational services	0.2	3.6
Schools	0.1	3.5
Elementary and secondary	0.1	3.4
Colleges and universities	0.5	4.1
Public administration(2)	0.3	3.7

(1) Consists of private industry workers (excluding farm and household workers) and State and local government (excluding Federal Government) workers.

(2) Consists of legislative, judicial, administrative, and regulatory activities.

(3) This series has the same industry and occupational coverage as the Hourly Earnings index, which was discontinued in January 1989.

(4) Includes, for example, library, social, and health services.

23. Employment Cost Index, benefits, private industry workers by occupation and Industry group

(June 1989 = 100)

Series	1998 June	1998 Sept.	1998 Dec.
Private industrial workers			
Workers, Industry by	143.7	144.5	145.2
occupational workers group:			
White-collar workers	145.6	146.6	147.4
Blue-collar workers	140.4	141.0	141.6
Workers, by industry division:			
Goods-producing	142.5	143.0	143.2
Service-producing	143.8	144.9	145.7
Manufacturing	142.4	142.6	142.7
Nonmanufacturing	143.9	145.0	145.8

Series	1999 Mar.	1999 June	1999 Sept.
Private industrial workers			
Workers, Industry by	145.8	147.3	148.6
occupational workers group:			
White-collar workers	147.9	149.4	151.0
Blue-collar workers	142.2	143.6	144.8
Workers, by industry division:			
Goods-producing	144.3	145.2	146.3
Service-producing	146.1	147.9	149.4

Series			
Manufacturing	143.6	144.5	145.7
Nonmanufacturing	146.3	148.0	149.4

Series	2000 Dec.	Mar.	June.
Private industrial workers			
Workers, Industry by	150.2	153.8	155.7
occupational workers group:			
White-collar workers	152.5	156.3	158.5
Blue-collar workers	146.2	150.0	151.6
Workers, by industry division:			
Goods-producing	148.2	152.3	154.2
Service-producing	150.7	154.0	156.0
Manufacturing	147.8	152.3	153.9
Nonmanufacturing	150.7	154.0	156.1

Series	Percent change 3 months ended June 2000	12 months ended June 2000
Private industrial workers		
Workers, Industry by	1.2	5.7
occupational workers group:		
White-collar workers	1.4	6.1
Blue-collar workers	1.1	5.6
Workers, by industry division:		
Goods-producing	1.2	6.2
Service-producing	1.3	5.5
Manufacturing	1.1	6.5
Nonmanufacturing	1.4	5.5

(24) Employment Cost Index, private nonfarm workers by bargaining status, region, and area size
(June 1989 = 100)

Series	1998 June.	Sept.	Dec.
COMPENSATION			
Workers, by bargaining status(1)			
Union	135.3	136.8	137.5
Goods-producing	134.3	135.6	136.5
Service-producing	136.2	138.0	138.5
Manufacturing	134.6	136.0	136.9
Nonmanufacturing	135.3	136.9	137.4
Nonunion	137.8	139.3	140.1
Goods-producing	136.9	137.7	138.3
Service-producing	138.0	139.7	140.6
Manufacturing	138.0	138.9	139.4
Nonmanufacturing	137.5	139.1	140.0
Workers, by region(1)			
Northeast	137.0	138.7	139.5
South	136.4	137.6	138.1
Midwest (formerly North Central)	139.6	140.9	141.4

West	136.6	138.5	140.0
Workers, by area size(1)			
Metropolitan areas	137.5	139.1	139.8
Other areas	137.1	138.2	139.4
WAGES AND SALARIES			
Workers, by bargaining status(1)			
Union	130.7	132.4	133.6
Goods-producing	129.4	131.0	132.3
Service-producing	132.2	134.1	135.4
Manufacturing	130.4	132.2	133.8
Nonmanufacturing	130.8	132.4	133.7
Nonunion	135.7	137.4	139.0
Goods-producing	134.7	135.7	137.8
Service-producing	135.9	137.9	139.3
Manufacturing	136.2	137.3	138.2
Nonmanufacturing	135.3	137.1	138.0
Workers, by region(1)			
Northeast	133.8	135.4	136.4
South	134.9	136.5	136.7
Midwest (formerly North Central)	136.0	137.5	138.0
West	134.5	136.7	138.4
Workers, by area size(1)			
Metropolitan areas	135.1	136.9	137.7
Other areas	133.4	134.7	136.0

Series	1999 Mar.	June	Sept.
COMPENSATION			
Workers, by bargaining status(1)			
Union	138.0	139.0	140.2
Goods-producing	136.8	138.2	139.2
Service-producing	139.2	139.7	141.0
Manufacturing	137.0	138.1	139.1
Nonmanufacturing	138.1	139.2	140.3
Nonunion	140.8	142.5	143.8
Goods-producing	139.7	140.5	141.8
Service-producing	141.1	143.0	144.4
Manufacturing	140.7	141.7	143.0
Nonmanufacturing	140.6	142.4	143.8
Workers, by region(1)			
Northeast	140.5	141.5	143.2
South	139.1	140.7	141.8
Midwest (formerly North Central)	141.7	143.6	145.0

West	140.3	142.1	143.3
Workers, by area size(1)			
Metropolitan areas	140.4	142.0	143.3
Other areas	140.5	141.8	143.1
WAGES AND SALARIES			
Workers, by bargaining status(1)			
Union	133.6	134.7	135.7
Goods-producing	132.3	133.8	134.9
Service-producing	135.4	135.8	136.8
Manufacturing	133.6	134.7	135.8
Nonmanufacturing	133.7	134.6	135.6
Nonunion	139.0	140.7	142.0
Goods-producing	137.8	138.8	140.0
Service-producing	139.3	141.3	142.6
Manufacturing	139.4	140.5	141.7
Nonmanufacturing	138.6	140.5	141.8
Workers, by region(1)			
Northeast	137.1	138.2	139.9
South	137.9	139.4	140.2
Midwest (formerly North Central)	138.9	141.0	142.4
West	138.2	140.2	141.3
Workers, by area size(1)			
Metropolitan areas	138.3	139.9	141.2
Other areas	137.1	138.4	139.8

	1999	2000	
Series	Dec.	Mar.	June
COMPENSATION			
Workers, by bargaining status(1)			
Union	141.2	143.0	144.4
Goods-producing	140.8	143.3	144.8
Service-producing	141.4	142.5	143.9
Manufacturing	141.0	144.5	145.4
Nonmanufacturing	140.8	141.7	143.4
Nonunion	145.2	147.4	149.1
Goods-producing	143.1	145.4	147.2
Service-producing	145.7	148.0	149.6
Manufacturing	144.4	146.5	148.2
Nonmanufacturing	145.1	147.4	149.1
Workers, by region(1)			
Northeast	144.3	146.3	147.6
South	143.0	145.0	146.7
Midwest (formerly North Central)	146.3	148.9	150.7

West	144.7	147.0	148.8
Workers, by area size(1)			
Metropolitan areas	144.7	146.9	148.6
Other areas	143.6	146.0	147.7
WAGES AND SALARIES			
Workers, by bargaining status(1)			
Union	136.5	137.2	138.5
Goods-producing	136.1	137.2	138.4
Service-producing	137.2	137.6	138.9
Manufacturing	137.5	138.8	139.7
Nonmanufacturing	135.9	136.4	137.8
Nonunion	143.3	145.1	146.7
Goods-producing	141.0	142.9	144.7
Service-producing	141.1	145.8	147.3
Manufacturing	142.9	144.4	146.1
Nonmanufacturing	143.0	145.0	146.6
Workers, by region(1)			
Northeast	140.9	142.3	143.7
South	141.5	143.0	144.6
Midwest (formerly North Central)	143.6	145.3	147.1
West	142.6	144.7	146.3
Workers, by area size(1)			
Metropolitan areas	142.5	144.1	145.7
Other areas	140.2	142.2	143.7

Series	Percent change 3 months ended June 2000	Percent change 12 months ended June 2000
COMPENSATION		
Workers, by bargaining status(1)		
Union	1.0	3.9
Goods-producing	1.0	4.8
Service-producing	1.0	3.0
Manufacturing	.6	5.3
Nonmanufacturing	1.2	3.0
Nonunion	1.2	4.6
Goods-producing	1.2	4.8
Service-producing	1.1	4.6
Manufacturing	1.2	4.6
Nonmanufacturing	1.2	4.7
Workers, by region(1)		
Northeast	.9	4.3
South	1.2	4.3

Midwest (formerly North Central)	1.2	49.0
West	1.2	4.7
Workers, by area size(1)		
Metropolitan areas	1.2	4.6
Other areas	1.2	4.2
WAGES AND SALARIES		
Workers, by bargaining status(1)		
Union	.9	2.8
Goods-producing	.9	3.4
Service-producing	.9	2.3
Manufacturing	.6	3.7
Nonmanufacturing	1.0	2.4
Nonunion	1.1	4.3
Goods-producing	1.3	4.3
Service-producing	1.0	4.2
Manufacturing	1.2	4.0
Nonmanufacturing	1.1	4.3
Workers, by region(1)		
Northeast	1.0	4.0
South	1.1	3.7
Midwest (formerly North Central)	1.2	4.3
West	1.1	4.4
Workers, by area size(1)		
Metropolitan areas	1.1	4.1
Other areas	1.1	3.8

(1) The indexes are calculated differently from those for the occupation and industry groups For a detailed description of the index calculation, see the Monthly Labor Review Technical Note, "Estimation procedures for the Employment Cost Index," May 1982.

25. Percent or full-time employees participating in employer-provided benefit plans, and in select features within plans, medium and large private establishments, selected years, 1980-97

Item	1980	1982	1984
Scope of survey (in 000's)	21,352	21,043	21,013
Number of employees (in 000's):			
With medical care	20,711	20,412	20,383
With life insurance	20,498	20,201	20,172
With defined benefit plan	17,936	17,676	17,231
Time-off plans			
Participants with:			
Paid lunch time	10	9	9
Average minutes per day	--	25	26
Paid rest time	75	76	73
Average minutes per day	--	25	26
Paid funeral leave	--	--	--
Average days per occurrence	--	--	--
Paid holidays	99	99	99
Average days per year	10.1	10.0	9.8

Paid personal leave	20	24	23
Average days per year	--	3.8	3.6
Paid vacations	100	99	99
Paid sick leave(1)	62	67	67
Unpaid maternity leave	--	--	--
Unpaid paternity leave	--	--	--
Unpaid family leave	--	--	--
Insurance plans			
Participants in medical care plans	97	97	97
Percent of participants with coverage for:			
Home health care	--	--	46
Extended care facilities	58	62	62
Physical exam	--	--	8
Percent of participants with employee contribution required for:			
Self coverage	26	27	36
Average monthly contribution	--	--	$11.93
Family coverage	46	51	58
Average monthly corporation			$35.93
Participants in life insurance plans	96	96	96
Percent of participants with:			
Accidental death and dismemberment insurance	69	72	74
Survivor income benefits	--	--	-
Retiree protection available	--	64	64
Participants in long-term disability insurance plans	40	43	47
Participants in sickness and accident insurance plans	54	51	51
Participants in short-term disability plans(1)	--	--	--
Retirement plans			
Participants in defined benefit pension plans	84	84	82
Percent of participants with:			
Normal retirement prior to age 65	55	58	63
Early retirement available	98	97	97
Ad hoc pension increase in last 5 years	--	--	47
Terminal earnings formula	53	52	54
Benefit coordinated with Social Security	45	45	56
Participants in defined contribution plans	--	--	--
Participants in plans with tax-deferred savings arrangements	--	--	--
Other benefits			
Employees eligible for:			
Flexible benefits plans	--	--	--
Reimbursement accounts(2)		--	--

Premium conversion plans	--	--	--
	1986	1988	1989
Item			
	21,303	31,059	32,428
Scope of survey (in 000's)			
Number of employees (in 000's):	20,238	27,953	29,834
With medical care	20,451	28,574	30,482
With life insurance	16,190	19,567	20,430
With defined benefit plan			
Time-off plans			
Participants with:	10	11	10
Paid lunch time	27	29	26
Average minutes per day	72	72	71
Paid rest time	26	26	26
Average minutes per day	88	85	84
Paid funeral leave	3.2	3.2	3.3
Average days per occurrence	99	96	97
Paid holidays	10.0	9.4	9.2
Average days per year	25	24	22
Paid personal leave	3.7	3.3	3.1
Average days per year	100	98	97
Paid vacations	70	69	68
Paid sick leave(1)	--	33	37
Unpaid maternity leave	--	16	18
Unpaid paternity leave	--	--	-
Unpaid family leave			
Insurance plans			
	95	90	92
Participants in medical care plans			
Percent of participants			
with coverage for:	66	76	75
Home health care	70	79	80
Extended care facilities	18	28	28
Physical exam			
Percent of participants			
with employee			
contribution required for:	43	44	47
Self coverage	$12.80	$19.29	$25.31
Average monthly contribution	63	64	66
Family coverage	$41.40	$60.07	$72.10
Average monthly corporation			
	96	92	94
Participants in life insurance plans			
Percent of participants with:			
Accidental death and	72	78	71
dismemberment insurance	10	8	7
Survivor income benefits	59	49	42
Retiree protection available			
Participants in long-term disability insurance plans	48	42	45
Participants in sickness and accident insurance plans	49	46	43
Participants in short-term disability plans(1)	--	--	-
Retirement plans			
Participants in defined	76	63	63

benefit pension plans			
Percent of participants with:			
Normal retirement prior	64	59	62
to age 65	98	98	97
Early retirement available			
Ad hoc pension increase	35	26	22
in last 5 years	57	55	64
Terminal earnings formula			
Benefit coordinated with	62	62	63
Social Security			
Participants in defined	60	45	48
contribution plans			
Participants in plans with			
tax-deferred savings	33	36	41
arrangements			
Other benefits			
Employees eligible for:	2	5	9
Flexible benefits plans			
	5	12	23
Reimbursement accounts(2)	--	--	--
Premium conversion plans			

Item	1991	1993	1995
Scope of survey (in 000's)	31,163	28,728	33,374
Number of employees (in 000's):			
With medical care	25,865	23,519	25,546
With life insurance	29,293	26,175	29,078
With defined benefit plan	18,386	16,015	17,417
Time-off plans			
Participants with:			
Paid lunch time	8	9	-
Average minutes per day	30	29	-
Paid rest time	67	68	-
Average minutes per day	28	26	-
Paid funeral leave	80	83	80
Average days per occurrence	3.3	3.0	3.3
Paid holidays	92	91	89
Average days per year	10.2	9.4	9.1
Paid personal leave	21	21	22
Average days per year	3.3	3.1	3.3
Paid vacations	96	97	96
Paid sick leave(1)	67	65	58
Unpaid maternity leave	37	60	-
Unpaid paternity leave	26	53	84
Unpaid family leave	--	--	-
Insurance plans			
Participants in medical care plans	83	82	77
Percent of participants			
with coverage for:			
Home health care	81	86	78
Extended care facilities	80	82	73
Physical exam	30	42	56
Percent of participants			
with employee			
contribution required for:			

Self coverage	51	61	67
Average monthly contribution	$26.60	$31.55	$33.92
Family coverage	69	76	78
Average monthly corporation	$96.97	$107.42	$118.33
Participants in life insurance plans	94	91	87
Percent of participants with:			
Accidental death and dismemberment insurance	71	76	77
Survivor income benefits	6	5	7
Retiree protection available	44	41	37
Participants in long-term disability insurance plans	40	41	42
Participants in sickness and accident insurance plans	45	44	-
Participants in short-term disability plans(1)	--	--	53
Retirement plans			
Participants in defined benefit pension plans	59	56	52
Percent of participants with:			
Normal retirement prior to age 65	55	52	52
Early retirement available	98	95	96
Ad hoc pension increase in last 5 years	7	6	4
Terminal earnings formula	56	61	58
Benefit coordinated with Social Security	54	48	51
Participants in defined contribution plans	48	49	55
Participants in plans with tax-deferred savings arrangements	44	43	54
Other benefits			
Employees eligible for:			
Flexible benefits plans	10	12	12
Reimbursement accounts(2)	36	52	38
Premium conversion plans	--	--	--

Item	1997
Scope of survey (in 000's)	38,409
Number of employees (in 000's):	
With medical care	29,340
With life insurance	33,495
With defined benefit plan	19,202
Time-off plans	
Participants with:	
Paid lunch time	--
Average minutes per day	--
Paid rest time	--
Average minutes per day	--
Paid funeral leave	81
Average days per occurrence	3.7

Paid holidays	89
Average days per year	9.3
Paid personal leave	20
Average days per year	3.5
Paid vacations	95
Paid sick leave(1)	56
Unpaid maternity leave	--
Unpaid paternity leave	93
Unpaid family leave	--
Insurance plans	
Participants in medical care plans	76
Percent of participants with coverage for:	
Home health care	85
Extended care facilities	78
Physical exam	63
Percent of participants with employee contribution required for:	
Self coverage	69
Average monthly contribution	$39.14
Family coverage	80
Average monthly corporation	$130.07
Participants in life insurance plans	87
Percent of participants with:	
Accidental death and dismemberment insurance	74
Survivor income benefits	6
Retiree protection available	33
Participants in long-term disability insurance plans	43
Participants in sickness and accident insurance plans	--
Participants in short-term disability plans(1)	55
Retirement plans	
Participants in defined benefit pension plans	50
Percent of participants with:	
Normal retirement prior to age 65	52
Early retirement available	95
Ad hoc pension increase in last 5 years	10
Terminal earnings formula	56
Benefit coordinated with Social Security	49
Participants in defined contribution plans	57
Participants in plans with tax-deferred savings arrangements	55
Other benefits	
Employees eligible for:	
Flexible benefits plans	13

Reimbursement accounts(2)	32
Premium conversion plans	7

(1) The definitions for paid sick leave and short-term disability (previously sickness and accident insurance) were changed for the 1995 survey. Paid sick leave now includes only plans that specify either a maximum number of days per year or unlimited days. Short-terms disability now includes all insured, self-insured, and State-mandated plans available on a per-disability basis, as well as the unfunded per-disability plans previously reported as sick leave. Sickness and accident insurance, reported in years prior to this survey, included only insured, self-insured, and State-mandated plans providing per-disability benefits at less than full pay.

(2) Prior to 1995, reimbursement accounts included premium conversion plans, which specifically allow medical plan participants to pay required plan premiums with pretax dollars. Also, reimbursement accounts that were part of flexible benefit plans were tabulated separately.

NOTE: Dash indicates data not available.

26 Percent of full-time employees participating in employer-provided benefit plans, and in selected features within plans, small private establishments and State and local governments, 1987, 1990, 1992, 1994, and 1996

Item	Small private establishments		
	1990	1992	1994
Scope of survey (in 000's)	32,466	34,360	35,910
Number of employees (in 000's):			
With medical care	22,402	24,396	23,536
With life insurance	20,778	21,990	21,955
With defined benefit plans	6,493	7,559	5,480
Time-off plans			
Participants with:			
Paid lunch time	8	9	--
Average minutes par day	37	37	--
Paid rest time	48	49	--
Average minutes per day	27	26	--
Paid funeral leave	47	50	50
Average clays per occurrence	2.9	3.0	3.1
Paid holidays	84	82	82
Average days per year(1)	9.5	9.2	7.5
Paid personal leave	11	12	13
Average days per year	2.8	2.6	2.6
Paid vacations	88	88	88
Paid sick leave(2)	47	53	50
Unpaid leave	17	18	--
Unpaid paternity leave	8	7	--
Unpaid family leave	--	--	47
Insurance plans			
Participants in medical care plans	69	71	66
Percent of participants with coverage for:			
Home health care	79	80	--
Extended care facilities	83	84	--
Physical exam	26	24	--
Percent of participants with employee contribution required for:			

Self coverage	42	47	52
Average monthly contribution	$25.13	$36.51	$40.97
Family coverage	67	73	76
Average monthly contribution	$109.34	$150.54	$159.63
Participants in life insurance plans	64	64	61
Percent of participants with:			
Accidental death and dismemberment insurance	78	76	79
Survivor income benefits	1	1	2
Retiree protection available	19	25	20
Participants in long-term disability insurance plans	19	23	20
Participants in sickness and accident insurance plans	6	26	26
Participants in short-term disability plans(2)	--	--	--
Retirement plans			
Participants in defined benefit pension plans	20	22	15
Percent of participants with:			
Normal retirement prior to age 65	54	50	--
Early retirement available	95	95	--
Ad hoc pension increase in last 5 years	7	4	--
Terminal earnings formula	58	54	--
Benefit coordinated with Social Security	49	46	--
Participants in defined contribution plans	31	33	34
Participants in plans with tax-deferred savings arrangements	17	24	23
Other benefits			
Employees eligible for:			
Flexible benefits plans	1	2	3
Reimbursement accounts(3)	8	14	19
Premium conversion plan	--	--	--

	Small private establisment	State and local governments	
Item	1996	1987	1990
Scope of survey (in 000's)	39,816	10,321	12,972
Number of employees (in 000's):			
With medical care	25,599	9,599	12,064
With life insurance	24,635	8,773	11,415
With defined benefit plans	5,883	9,599	11,675
Time-off plans			
Participants with:			
Paid lunch time	--	17	11
Average minutes par day	--	34	36
Paid rest time	--	58	56

Average minutes per day	--	29	29
Paid funeral leave	51	56	63
Average clays per occurrence	3.0	3.7	3.7
Paid holidays	81	81	74
Average days per year(1)	7.6	10.9	13.6
Paid personal leave	14	38	39
Average days per year	3.0	2.7	2.9
Paid vacations	86	72	67
Paid sick leave(2)	50	97	95
Unpaid leave	--	57	51
Unpaid paternity leave	--	30	33
Unpaid family leave	48	--	--
Insurance plans			
Participants in medical care plans	64	93	93
Percent of participants with coverage for:			
Home health care	--	76	82
Extended care facilities	--	78	79
Physical exam	--	36	36
Percent of participants with employee contribution required for:			
Self coverage	52	35	38
Average monthly contribution	$42.63	$15.74	$25.53
Family coverage	75	71	65
Average monthly contribution	$181.53	$71.89	$117.59
Participants in life insurance plans	62	85	88
Percent of participants with:			
Accidental death and dismemberment insurance	77	67	67
Survivor income benefits	1	1	1
Retiree protection available	13	55	45
Participants in long-term disability insurance plans	22	31	27
Participants in sickness and accident insurance plans	--	14	21
Participants in short-term disability plans(2)	29	--	--
Retirement plans			
Participants in defined benefit pension plans	15	93	90
Percent of participants with:			
Normal retirement prior to age 65	47	92	89
Early retirement available	92	90	88
Ad hoc pension increase in last 5 years	--	33	16
Terminal earnings formula	53	100	100
Benefit coordinated with Social Security	44	18	8
Participants in defined contribution plans	38	9	9
Participants in plans with tax-deferred savings arrangements	28	28	45
Other benefits			

Employees eligible for:			
Flexible benefits plans	4	5	5
Reimbursement accounts(3)	12	5	31
Premium conversion plan	--	--	--

Item	State and local government	
	1992	1994
Scope of survey (in 000's)	12,466	12,907
Number of employees (in 000's):		
With medical care	112,191	11,192
With life insurance	110,951	11,194
With defined benefit plans	10,845	11,708
Time-off plans		
Participants with:		
Paid lunch time	10	--
Average minutes par day	34	--
Paid rest time	53	--
Average minutes per day	29	--
Paid funeral leave	65	62
Average clays per occurrence	3.7	3.7
Paid holidays	75	73
Average days per year(1)	14.2	11.5
Paid personal leave	38	38
Average days per year	2.9	3.0
Paid vacations	67	66
Paid sick leave(2)	95	94
Unpaid leave	59	--
Unpaid paternity leave	44	--
Unpaid family leave	--	93
Insurance plans		
Participants in medical care plans	90	87
Percent of participants with coverage for:		
Home health care	87	84
Extended care facilities	84	81
Physical exam	47	55
Percent of participants with employee contribution required for:		
Self coverage	42	47
Average monthly contribution	$28.97	$30.20
Family coverage	72	71
Average monthly contribution	$139.23	$149.70
Participants in life insurance plans	89	87
Percent of participants with:		
Accidental death and dismemberment insurance	74	64
Survivor income benefits	1	2
Retiree protection available	46	46
Participants in long-term disability insurance plans	28	30
Participants in sickness and accident insurance plans	22	21
Participants in short-term disability plans(2)	--	--

Retirement plans		
Participants in defined benefit pension plans	87	91
Percent of participants with:		
Normal retirement prior to age 65	92	92
Early retirement available	89	87
Ad hoc pension increase in last 5 years	10	13
Terminal earnings formula	100	49
Benefit coordinated with Social Security	10	9
Participants in defined contribution plans	9	9
Participants in plans with tax-deferred savings arrangements	45	24
Other benefits		
Employees eligible for:		
Flexible benefits plans	5	5
Reimbursement accounts(3)	50	64
Premium conversion plan	--	--

(1) Methods used to calculate the average number of paid holidays were revised in 1994 to count partial days more precisely Average holidays for 1994 are not comparable with those reported in 1990 and 1992

(2) The definitions for paid sick leave and short-term disability (previously sickness and accident insurance) were changed for the 1996 survey Paid sick leave now includes only plans that specify either a maximum number of days per year or unlimited days Short-term disability now includes all insured, serf-insured, and State-mandated plans available on a par-disability basis, as well as the unfunded per-disability plans previously reported as sick leave. Sickness and accident insurance, reported in years prior to this survey, included only insured, serf-insured, and State-mandated plans providing par-disability benefits at less than full pay.

(3) Prior to 1996, reimbursement accounts included premium conversion plans, which specifically allow medical plan participants to pay required plan premiums with pretax dollars. Also, reimbursement accounts that were pert of flexible benefit plans were tabulated separately.

NOTE: Dash indicates data not available.

27. Work stoppages involving 1,000 workers or more

Measure	Annual totals		1999	
	1998	1999	Apr.	May
Number of stoppages				
Beginning in period	34	17	2	3
In effect during period	34	21	4	6
Workers involved:				
Beginning in period (in thousand)	387	73	19.0	9.6
In effect during period	387	80	23.4	22.0
Days idle:				
Number (in thousands)	5,116	1,995	272.4	314.8
Percent of estimated working time(1)	.02	.01	.01	.01

Measure

Measure	June	July	Aug.	Sept.
Number of stoppages				
Beginning in period	2	1	11	2
In effect during period	6	6	3	5
Workers involved:				
Beginning in period (in thousand)	2.2	1.7	11.0	19.1
In effect during period	21.6	16.3	15.4	34.5
Days idle:				
Number (in thousands)	309.4	266.4	118.8	176.2
Percent of estimated working time(1)	.01	.01	(2)	.01

Measure	1999 Oct.	1999 Nov.	1999 Dec.	2000 Jan.(p)
Number of stoppages				
Beginning in period	0	1	0	0
In effect during period	2	2	1	1
Workers involved:				
Beginning in period (in thousand)	.0	2.0	.0	.0
In effect during period	10.1	5.0	3.0	3.0
Days idle:				
Number (in thousands)	67.1	63.6	63.0	60.0
Percent of estimated working time(1)	(2)	(2)	(2)	(2)

Measure	2000 Feb.(p)	2000 Mar.(p)	2000 Apr.(p)
Number of stoppages			
Beginning in period	1	2	6
In effect during period	2	4	7
Workers involved:			
Beginning in period (in thousand)	17.0	5.7	26.7
In effect during period	20.0	25.7	29.7
Days idle:			
Number (in thousands)	298.0	327.6	272.2
Percent of estimated working time(1)	.01	.01	.01

(1) Agricultural and government employees are included in the total employed and total working time; private household, forestry, and fishery employees are excluded. An explanation of the measurement of idleness as a percentage of the total time worked is found in" `Total economy' measures of strike idleness," Month/y Labor Review, October 1968, pp. 54-56.

(2) Less than 0.005.

(p) = preliminary.

28. Consumer Price Indexes for All Urban Consumers and for Urban Wage Earners and Clerical Workers: U.S. city average, by expenditure category and commodity or service group

(1982-84 = 100, unless otherwise indicated)

Series	Annual Average	1999

	1998	1999	Aug.
CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS			
All items	163.0	166.6	167.1
All items (1967 = 100)	488.3	499.0	500.7
Food and beverages	161.1	164.6	164.7
Food	160.7	164.1	164.2
Food at home	161.1	164 2	164.1
Cereals and bakery products	181.1	185.0	184.9
Meats, poultry, fish, and eggs	147.3	147.9	148.5
Dairy and related products(1)	150.8	159.6	156.5
Fruits and vegetables	198.2	203.1	202.1
Nonalcoholic beverages and beverage materials	133.0	134.3	134.5
Other foods at home	150.8	153.5	154.2
Sugar and sweets	150.2	152.3	152.7
Fats and oils	146.9	148.3	148.6
Other foods	165.5	168.9	169.9
Other miscellaneous foods(1,2)	102.6	104.9	104.8
Food away from home(1)	161 1	165.1	165.6
Other food away from home(1,2)	101.6	105.2	105.8
Alcoholic beverages	165.7	169.7	170.2
Housing	160.4	163.9	165.0
Shelter	182.1	187.3	188.3
Rent of primary residence	172.1	177.5	177.9
Lodging away from home	109.0	112.3	117.1
Owners' equivalent rent of primary residence(3)	187.8	192.9	193.4
Tenants' and household insurance(1,2)	99.8	101.2	102.2
Fuels and utilities	128.8	128.8	131.4
Fuels	113.7	113.5	116.2
Fuel oil and other fuels	90.0	91.4	89.2
Gas (piped) and electricity	121.2	120.9	124.1
Household furnishings and operations	126.6	126.7	126.8
Apparel	133.0	131.3	127.5
Men's and boys' apparel	131.8	131.1	127.1
Women's and girls' apparel	126.0	123.3	117.9
Infants' and toddlers' apparel(1)	126.1	129.0	128.3
Footwear	128.0	125.7	123.8
Transportation	141.6	144.4	145.7
Private transportation	137.9	140.5	141.9
New and used motor vehicles(2)	100.1	100.1	99.7
New vehicles	143.4	142.9	141.4
Used cars and trucks(1)	150.6	152.0	153.8
Motor fuel	92.2	100.7	107.8
Gasoline (all types)	91.6	100.1	107.2
Motor vehicle parts and equipment	101.1	100.5	100.1
Motor vehicle maintenance and repair	167.1	171.9	172.1
Public transportation	190.3	197.7	197.1
Medical care	242.1	250.6	251.9
Medical care commodities	221.8	230.7	232.5
Medical care services	246.8	255.1	256.2
Professional services	222.2	229.2	230.1
Hospital and related services	287.5	299.5	301.3
Recreation(2)	101.1	102.1	102.2
Video and audio(1,2)	101.1	100.7	100.9
Education and communication(2)	100.3	101.2	101.2

Education(2)	102.1	107.0	107.5
Educational books and supplies	250.8	261.7	264.5
Tuition, other school fees, and child care	294.2	308.4	309.9
Communication(1,2)	98.7	96.0	95.6
Information and information processing(1,2)	98.5	95.5	95.0
Telephone services(1,2)	100.7	100.1	99.8
Information and information processing other than telephone services(1,4)	39.9	30.5	29.8
Personal computers and peripheral equipment(1,2)	78.2	53.5	50.9
Other goods and services	237.7	258.3	257.6
Tobacco and smoking products	274.8	355.8	350.1
Personal care(1)	156.7	161.1	161.4
Personal Care products(1)	148.3	151.8	152.3
Personal care services(1)	166.0	171.4	171.9
Miscellaneous personal services	234.7	243.0	243.9
Commodity and service group:			
Commodities	141.9	144.4	144.5
Food and beverages	161.1	164.6	164.7
Commodities less food and beverages	130.5	132.5	132.5
Nondurables less food and beverages	132.6	137.5	138.0
Apparel	133.0	131.3	127.5
Nondurables less food, beverages, and apparel	137.4	146.0	148.8
Durables	127.6	126.0	125.4
Services	164.2	188.8	189.9
Rent of shelter(3)	189.6	195.0	195.1
Transportation services	187.9	190.7	190.2
Other services	216.9	223.1	223.9
Special indexes:			
All items less food	163.4	167.0	167.7
All items less shelter	157.2	160.2	160.6
All Items less medical care	158.6	162.0	162.5
Commodities less food	132.0	134.0	134.0
Nondurables less food	134.6	139.4	139.9
Nondurables less food and apparel	139.2	147.5	150.0
Nondurables	146.9	151.2	151.5
Services less rent of shelter(3)	191.8	195.8	196.9
Services less medical care services	178.4	182.7	163.8
Energy	102.9	106.6	111.3
All items less energy	170.9	174.4	174.5
All items less food and energy	173.4	177.0	177.1
Commodities less food and energy	143.2	144.1	143.0
Energy commodities	92.1	100.0	106.3
Services less energy	190.6	195.7	196.5

CONSUMER PRICE INDEX FOR URBAN
WAGE EARNERS AND CLERICAL WORKERS

All items	159.7	163.2	163.8
All items (1967 = 100)	475.6	486.2	487.8
Food and beverages	160.4	163.8	163.9
Food	160.0	163.4	163.5
Food at home	160.0	163.0	162.9
Cereals and bakery products	180.9	184.7	184.8
Meats, poultry, fish, and eggs	147.0	147.6	148.2

Dairy and related products(1)	150.4	159.4	156.0
Fruits and vegetables	197.0	201.8	201.2
Nonalcoholic beverages and beverage materials	131.8	133.2	133.2
Other foods at home	150.2	152.8	153.5
Sugar and sweets	150.1	152.2	152.6
Fats and oils	146.5	147.9	148.3
Other foods	165.4	168.8	169.7
Other miscellaneous foods(1,2)	102.6	104.6	104.4
Food away from home(1)	161.1	165.0	165.5
Other food away from home(1,2)	101.6	105.1	105.8
Alcoholic beverages	164.6	168.8	169.2
Housing	156.7	160.0	161.0
Shelter	176.6	181.6	182.4
Rent of primary residence	171.7	177.1	177.5
Lodging away from home(2)	109.0	122.2	116.8
Owners' equivalent rent of primary residence(3)	171.1	175.7	176.1
Tenants' and household insurance(1,2)	100.0	101.6	102.3
Fuels and utilities	128.4	128.7	131.4
Fuels	113.3	113.0	115.9
Fuel oil and other fuels	90.3	91.7	89.3
Gas (piped) and electricity	120.8	120.4	123.7
Household furnishings and operations	125.0	124.7	124.7
Apparel	131.6	130.1	126.4
Men's and boys' apparel	131.4	131.2	127.2
Women's and girls' apparel	123.9	121.3	115.0
Infants' and toddlers' apparel(1)	126.7	130.3	129.6
Footwear	128.7	126.2	124.4
Transportation	140.5	143.4	145.0
Private transportation	138.0	140.7	142.4
New and used motor vehicles(2)	100.3	100.4	100.2
New vehicles	144.6	144.0	142.6
Used cars and trucks(1)	152.0	153.3	155.2
Motor fuel	92.2	100.8	107.8
Gasoline (all types)	91.7	100.2	107.3
Motor vehicle parts and equipment	100.5	100.0	99.6
Motor vehicle maintenance and repair	168.2	173.3	173.5
Public transportation	187.1	193.1	192.5
Medical care	241.4	249.7	251.0
Medical care commodities	218.6	226.8	228.4
Medical care services	246.6	254.9	
Professional services	223.7	230.8	231.7
Hospital and related services	283.6	295.5	297.3
Recreation(2)	100.9	101.3	101.5
Video and audio(1,2)	101.1	100.5	100.7
Education and communication(2)	100.4	101.5	101.5
Education(2)	102.1	107.2	107.7
Educational books and supplies	253.1	264.1	267.2
Tuition, other school fees, and child care	288.5	302.8	304.1
Communication(1,2)	99.1	96.9	96.5
Information and information processing(1,2)	99.0	96.5	96.1
Telephone services(1,2)	100.7	100.2	99.9
Information and information processing other than telephone services(1,4)	41.2	31.6	30.8
Personal computers and			

peripheral equipment(1,2)	77.9	53.1	50.6
Other goods and services	236.1	261.9	260.7
Tobacco and smoking products	274.8	356.2	350.6
Personal care(1)	156.8	161.3	161.6
Personal Care products(1)	149.3	152.5	153.1
Personal care services(1)	166.3	171.7	172.2
Miscellaneous personal services	234.0	243.1	243.8
Commodity and service group:			
Commodities	141.8	144.7	144.8
Food and beverages	160.4	163.8	163.9
Commodities less food and beverages	130.6	133.2	133.4
Nondurables less food and beverages	132.1	138.1	138.8
Apparel	131.6	130.1	126.4
Nondurables less food, beverages, and apparel	137.0	147.2	150.2
Durables	127.3	126.0	125.7
Services	181.0	185.3	186.3
Rent of shelter(3)	170.1	174.9	175.6
Transportation services	185.4	187.9	187.4
Other services	213.7	219.6	220.3
Special indexes:			
All items less food	159.5	163.1	163.7
All items less shelter	155.0	158.1	158.6
All Items less medical care	155.8	159.2	159.7
Commodities less food	132.0	134.6	134.8
Nondurables less food	134.1	140.0	140.7
Nondurables less food and apparel	138.7	148.4	151.2
Nondurables	146.5	151.3	151.7
Services less rent of shelter(3)	170.7	174.1	175.0
Services less medical care services	175.4	179.5	180.4
Energy	102.1	106.1	111.1
All items less energy	167.6	171.1	171.1
All items less food and energy	169.6	173.1	173.1
Commodities less food and energy	142.7	144.3	143.3
Energy commodities	92.3	100.3	106.8
Services less energy	187.7	192.6	193.2

Series	1999		
	Sept.	Oct.	Nov.
CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS			
All items	167.9	168.2	168.3
All items (1967 = 100)	502.9	503.9	504.1
Food and beverages	165.1	165.7	165.7
Food	164.6	165.2	165.2
Food at home	164.5	165.1	165.1
Cereals and bakery products	185.2	184.8	184.8
Meats, poultry, fish, and eggs	149.2	150.5	150.5
Dairy and related products(1)	158.7	164.6	164.6
Fruits and vegetables	202.6	202.2	201.2
Nonalcoholic beverages and beverage materials	134.2	134.6	133.9
Other foods at home	153.9	153.7	153.0
Sugar and sweets	153.5	135.3	152.1
Fats and oils	148.5	149.0	145.3
Other foods	169.2	168.7	169.0

Other miscellaneous foods(1,2)	105.3	104.3	103.9
Food away from home(1)	165.8	166.2	166.5
Other food away from home(1,2)	106.4	106.8	106.9
Alcoholic beverages	170.7	170.5	171.2
Housing	165.2	165.0	164.9
Shelter	188.3	188.5	188.6
Rent of primary residence	178.4	178.8	179.8
Lodging away from home	113.8	113.1	108.5
Owners' equivalent rent of primary residence(3)	193.9	194.2	194.9
Tenants' and household insurance(1,2)	102.3	102.2	102.1
Fuels and utilities	132.7	130.3	130.0
Fuels	117.6	115.0	114.6
Fuel oil and other fuels	93.9	97.6	100.7
Gas (piped) and electricity	125.3	122.0	121.4
Household furnishings and operations	127.0	126.6	126.4
Apparel	131.8	134.6	133.6
Men's and boys' apparel	130.5	134.0	133.2
Women's and girls' apparel	125.4	128.4	126.6
Infants' and toddlers' apparel(1)	129.9	132.4	132.6
Footwear	124.7	126.1	126.4
Transportation	146.5	147.3	147.6
Private transportation	142.9	143.3	143.6
New and used motor vehicles(2)	100.1	100.5	100.9
New vehicles	141.6	142.3	143.1
Used cars and trucks(1)	155.7	156.4	156.1
Motor fuel	110.3	110.0	109.3
Gasoline (all types)	109.7	109.4	108.7
Motor vehicle parts and equipment	100.6	100.5	101.2
Motor vehicle maintenance and repair	172.8	173.2	173.6
Public transportation	194.7	201.5	202.2
Medical care	252.3	252.8	253.3
Medical care commodities	233.1	233.2	233.7
Medical care services	256.6	257.1	257.7
Professional services	230.4	230.9	231.4
Hospital and related services	302.1	302.9	303.9
Recreation(2)	101.7	101.8	101.9
Video and audio(1,2)	100.1	100.1	100.1
Education and communication(2)	101.9	102.1	102.2
Education(2)	109.4	109.6	109.3
Educational books and supplies	267.0	269.0	255.7
Tuition, other school fees, and child care	315.3	315.9	316.3
Communication(1,2)	95.3	95.3	95.9
Information and information processing(1,2)	94.7	94.7	95.3
Telephone services(1,2)	99.6	99.8	100.6
Information and information processing other than telephone services(1,4)	29.3	28.7	28.2
Personal computers and peripheral equipment(1,2)	49.7	48.2	47.0
Other goods and services	262.6	263.2	263.0
Tobacco and smoking products	373.8	373.3	369.8
Personal care(1)	161.8	162.4	162.8
Personal Care products(1)	153.0	153.4	153.3
Personal care services(1)	172.1	172.9	173.9
Miscellaneous personal services	244.6	245.6	246.0
Commodity and service group:			

Commodities	145.8	146.4	146.2
Food and beverages	165.1	165.5	165.7
Commodities less food and beverages	134.3	134.9	134.6
Nondurables less food and beverages	141.0	141.9	141.3
Apparel	131.8	134.6	133.6
Nondurables less food, beverages, and apparel	151.2	151.2	150.7
Durables	125.7	125.9	126.0
Services	190.1	190.2	190.5
Rent of shelter(3)	196.1	195.3	196.3
Transportation services	189.9	191.9	192.7
Other services	224.5	225.1	226.0
Special indexes:			
All items less food	168.5	168.8	168.8
All items less shelter	161.6	162.0	162.1
All Items less medical care	163.2	163.6	163.6
Commodities less food	135.8	136.3	136.1
Nondurables less food	142.8	143.7	143.1
Nondurables less food and apparel	152.3	152.3	151.9
Nondurables	153.2	154.0	153.7
Services less rent of shelter(3)	197.3	197.4	197.9
Services less medical care services	163.9	184.1	184.3
Energy	113.2	111.6	111.2
All items less energy	175.1	175.7	175.8
All items less food and energy	177.7	178.3	178.4
Commodities less food and energy	144.6	145.3	145.0
Energy commodities	109.1	109.1	108.7
Services less energy	195.6	197.2	197.5

CONSUMER PRICE INDEX FOR URBAN WAGE EARNERS AND CLERICAL WORKERS

All items	164.7	165.0	165.1
All items (1967 = 100)	490.5	491.5	491.7
Food and beverages	164.3	164.7	164.9
Food	163.9	164.4	164.5
Food at home	163.5	164.0	164.0
Cereals and bakery products	165.0	165.0	184.5
Meats, poultry, fish, and eggs	148.9	148.8	150.1
Dairy and related products(1)	158.4	164.0	164.6
Fruits and vegetables	201.6	201.0	199.8
Nonalcoholic beverages and beverage materials	133.0	133.4	132.7
Other foods at home	163.3	152.9	152.3
Sugar and sweets	153.3	153.2	152.0
Fats and oils	148.1	148.6	144.9
Other foods	169.2	168.5	168.8
Other miscellaneous foods(1,2)	105.1	103.8	103.4
Food away from home(1)	165.8	166.1	166.5
Other food away from home(1,2)	106.2	106.6	106.8
Alcoholic beverages	169.8	169.5	170.4
Housing	161.3	161.0	161.1
Shelter	182.6	182.8	183.1
Rent of primary residence	178.0	178.4	179.3
Lodging away from home(2)	113.8	113.1	108.4
Owners' equivalent rent of primary residence(3)	176.5	176.8	177.4
Tenants' and household insurance(1,2)	102.5	102.4	102.3

Fuels and utilities	132.8	130.1	129.8
Fuels	117.2	114.4	114.0
Fuel oil and other fuels	93.9	97.7	100.7
Gas (piped) and electricity	124.9	121.5	120.9
Household furnishings and operations	124.8	124.5	124.2
Apparel	130.5	133.1	132.3
Men's and boys' apparel	130.3	134.0	133.3
Women's and girls' apparel	123.3	126.0	124.4
Infants' and toddlers' apparel(1)	131.4	134.1	134.3
Footwear	125.1	126.6	126.9
Transportation	146.0	146.6	146.9
Private transportation	143.6	143.9	144.2
New and used motor vehicles(2)	100.7	101.2	101.5
New vehicles	142.8	143.5	144.3
Used cars and trucks(1)	157.0	157.7	157.3
Motor fuel	110.6	110.0	109.5
Gasoline (all types)	110.0	109.4	108.9
Motor vehicle parts and equipment	99.9	99.8	100.6
Motor vehicle maintenance and repair	174.3	174.7	175.1
Public transportation	190.7	196.3	197.0
Medical care	251.4	251.9	252.5
Medical care commodities	229.0	229.1	229.5
Medical care services	256.4	257.0	257.6
Professional services	232.0	232.5	233.1
Hospital and related services	298.2	298.9	299.8
Recreation(2)	101.0	101.1	101.0
Video and audio(1,2)	99.8	99.9	99.9
Education and communication(2)	102.1	102.3	102.5
Education(2)	109.5	109.7	109.4
Educational books and supplies	269.9	271.8	256.5
Tuition, other school fees, and child care	309.5	310.0	310.4
Communication(1,2)	96.2	96.3	96.9
Information and information processing(1,2)	95.8	95.9	96.6
Telephone services(1,2)	99.7	100.0	100.8
Information and information processing other than telephone services(1,4)	30.3	29.9	29.3
Personal computers and peripheral equipment(1,2)	49.4	48.1	46.9
Other goods and services	267.3	267.9	267.3
Tobacco and smoking products	374.4	374.0	269.7
Personal care(1)	161.9	162.6	163.1
Personal Care products(1)	153.7	154.1	153.1
Personal care services(1)	172.4	173.2	174.7
Miscellaneous personal services	244.5	245.5	146.7
Commodity and service group:			
Commodities	146.3	146.8	146.6
Food and beverages	164.3	164.7	164.9
Commodities less food and beverages	135.4	165.9	135.6
Nondurables less food and beverages	142.1	142.9	142.2
Apparel	130.5	133.1	132.3
Nondurables less food, beverages, and apparel	153.2	153.1	152.5
Durables	126.1	126.3	126.4
Services	186.6	186.7	187.1
Rent of shelter(3)	175.8	176.1	176.3
Transportation services	187.3	189.0	189.8

Other services	220.9	221.6	222.3
Special indexes:			
All items less food	164.7	165.0	165.1
All items less shelter	159.7	160.1	160.1
All Items less medical care	160.7	161.0	161.1
Commodities less food	136.7	137.2	137.0
Nondurables less food	143.8	144.6	144.0
Nondurables less food and apparel	154.0	153.8	153.4
Nondurables	153.6	154.3	154.0
Services less rent of shelter(3)	175.5	175.4	175.8
Services less medical care services	180.7	180.8	181.1
Energy	113.1	111.4	111.0
All items less energy	171.8	172.4	172.6
All items less food and energy	173.9	174.5	174.7
Commodities less food and energy	145.0	145.7	145.4
Energy commodities	109.7	109.4	109.1
Services less energy	193.4	194.0	194.4

Series	1999 Dec.	2000 Jan.	Feb.
CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS			
All items	168.3	168.7	169.7
All items (1967 = 100)	504.1	505.5	508.4
Food and beverages	165.9	166.6	166.8
Food	165.4	166.1	166.3
Food at home	165.4	166.3	166.3
Cereals and bakery products	185.9	185.6	186.0
Meats, poultry, fish, and eggs	149.8	150.2	151.3
Dairy and related products(1)	162.1	160.4	160.9
Fruits and vegetables	204.5	208.4	203.0
Nonalcoholic beverages and beverage materials	134.7	137.1	138.4
Other foods at home	153.3	154.3	154.4
Sugar and sweets	152.3	154.8	154.4
Fats and oils	145.1	147.0	145.6
Other foods	169.4	169.8	170.5
Other miscellaneous foods(1,2)	105.7	104.3	106.4
Food away from home(1)	166.8	167.2	167.6
Other food away from home(1,2)	106.9	107.5	107.9
Alcoholic beverages	171.8	172.4	173.0
Housing	164.8	165.9	166.9
Shelter	188.6	189.8	190.7
Rent of primary residence	180.3	180.8	181.2
Lodging away from home	105.8	111.3	115.1
Owners' equivalent rent of primary residence(3)	195.2	195.7	196.1
Tenants' and household insurance(1,2)	102.2	102.4	102.4
Fuels and utilities	129.8	129.9	132.4
Fuels	114.1	114.3	117.6
Fuel oil and other fuels	106.3	114.4	147.2
Gas (piped) and electricity	120.3	119.8	120.6
Household furnishings and operations	126.4	127.0	127.2
Apparel	130.1	126.8	129.2
Men's and boys' apparel	131.5	129.2	130.0

Women's and girls' apparel	121.8	116.0	120.0
Infants' and toddlers' apparel(1)	133.0	133.3	133.1
Footwear	123.7	121.6	122.1
Transportation	148.3	148.3	149.7
Private transportation	144.4	144.4	145.6
New and used motor vehicles(2)	101.1	100.8	100.3
New vehicles	143.6	143.3	143.0
Used cars and trucks(1)	155.0	153.9	153.0
Motor fuel	112.2	112.9	118.1
Gasoline (all types)	111.5	111.9	117.3
Motor vehicle parts and equipment	100.8	100.8	100.9
Motor vehicle maintenance and repair	173.8	174.6	175.2
Public transportation	201.2	199.5	204.2
Medical care	254.2	255.5	257.0
Medical care commodities	234.6	235.2	235.5
Medical care services	258.5	260.1	262.0
Professional services	231.7	233.1	234.9
Hospital and related services	306.3	308.4	310.5
Recreation(2)	102.0	102.3	102.5
Video and audio(1,2)	100.1	100.5	100.6
Education and communication(2)	102.3	102.7	102.2
Education(2)	109.3	110.2	110.6
Educational books and supplies	256.0	273.9	278.3
Tuition, other school fees, and child care	316.3	317.3	318.0
Communication(1,2)	95.9	96.0	94.7
Information and information processing(1,2)	95.4	95.5	94.1
Telephone services(1,2)	100.7	100.9	99.4
Information and information processing other than telephone services(1,4)	28.2	28.0	27.6
Personal computers and peripheral equipment(1,2)	47.2	46.4	45.1
Other goods and services	263.0	264.7	266.7
Tobacco and smoking products	369.1	375.1	383.0
Personal care(1)	162.9	163.4	163.8
Personal Care products(1)	152.5	152.8	152.6
Personal care services(1)	174.3	174.9	175.9
Miscellaneous personal services	246.6	247.6	248.9
Commodity and service group:			
Commodities	146.1	146.2	147.4
Food and beverages	165.9	166.6	166.8
Commodities less food and beverages	134.4	134.0	135.7
Nondurables less food and beverages	140.9	140.5	143.9
Apparel	130.1	126.8	129.2
Nondurables less food, beverages, and apparel	152.1	153.1	157.2
Durables	125.9	125.7	125.3
Services	190.5	191.4	192.2
Rent of shelter(3)	196.3	197.6	198.5
Transportation services	192.8	193.0	193.7
Other services	226.5	227.4	227.4
Special indexes:			
All items less food	168.8	169.2	170.3
All items less shelter	162.1	162.3	163.3
All Items less medical care	163.6	164.0	164.9
Commodities less food	135.9	135.6	137.2
Nondurables less food	142.8	142.4	145.7
Nondurables less food and apparel	153.2	154.2	158.0

Nondurables	153.6	163.7	155.6
Services less rent of shelter(3)	198.0	198.6	199.2
Services less medical care services	184.3	185.1	185.8
Energy	112.2	112.5	116.7
All items less energy	175.7	176.2	176.8
All items less food and energy	178.2	178.7	179.4
Commodities less food and energy	144.2	143.6	144.2
Energy commodities	111.8	112.8	120.6
Services less energy	197.7	198.7	199.5

CONSUMER PRICE INDEX FOR URBAN WAGE EARNERS AND CLERICAL WORKERS

All items	165.1	165.5	166.4
All items (1967 = 100)	491.8	492.9	495.6
Food and beverages	165.2	165.9	166.1
Food	164.7	165.4	165.6
Food at home	164.2	165.1	165.1
Cereals and bakery products	165.7	165.5	165.8
Meats, poultry, fish, and eggs	149.4	149.8	150.8
Dairy and related products(1)	161.9	159.9	160.4
Fruits and vegetables	202.8	207.0	201.7
Nonalcoholic beverages and beverage materials	133.5	136.0	137.6
Other foods at home	152.7	153.7	163.8
Sugar and sweets	152.3	154.8	154.3
Fats and oils	144.7	146.8	146.2
Other foods	169.4	169.8	170.5
Other miscellaneous foods(1,2)	105.2	103.9	106.2
Food away from home(1)	166.8	167.1	167.6
Other food away from home(1,2)	106.9	107.4	107.8
Alcoholic beverages	171.0	171.6	172.2
Housing	151.1	161.8	162.7
Shelter	163.3	184.1	184.8
Rent of primary residence	179.9	180.3	180.7
Lodging away from home(2)	105.7	110.8	114.5
Owners' equivalent rent of primary residence(3)	177.8	178.2	178.6
Tenants' and household insurance(1,2)	102.4	102.6	102.6
Fuels and utilities	129.2	129.5	132.0
Fuels	113.5	113.6	116.3
Fuel oil and other fuels	106.0	114.0	144.5
Gas (piped) and electricity	119.8	119.4	120.1
Household furnishings and operations	124.2	124.5	124.6
Apparel	129.0	125.9	127.9
Men's and boys' apparel	131.6	129.3	129.9
Women's and girls' apparel	119.8	114.2	118.0
Infants' and toddlers' apparel(1)	134.8	134.9	134.7
Footwear	124.2	122.3	122.6
Transportation	147.6	147.7	149.1
Private transportation	145.0	145.1	146.4
New and used motor vehicles(2)	101.5	101.2	100.7
New vehicles	144.7	144.5	144.2
Used cars and trucks(1)	156.3	155.3	154.4
Motor fuel	112.3	112.9	118.6
Gasoline (all types)	111.7	112.3	117.9
Motor vehicle parts and equipment	100.2	100.3	100.5
Motor vehicle maintenance and			

repair	175.2	176.1	176.6
Public transportation	196.0	194.8	198.8
Medical care	253.2	254.5	256.2
Medical care commodities	230.2	230.7	231.0
Medical care services	258.4	259.9	261.9
Professional services	233.4	234.8	236.7
Hospital and related services	302.1	304.1	306.4
Recreation(2)	101.2	101.4	101.6
Video and audio(1,2)	99.8	100.2	100.4
Education and communication(2)	102.5	103.0	102.5
Education(2)	109.4	110.5	110.9
Educational books and supplies	256.9	276.6	281.3
Tuition, other school fees, and child care	310.4	311.7	312.7
Communication(1,2)	97.0	97.1	95.7
Information and information processing(1,2)	96.6	96.7	95.3
Telephone services(1,2)	100.9	101.1	99.6
Information and information processing other than telephone services(1,4)	29.3	28.9	28.6
Personal computers and peripheral equipment(1,2)	46.9	45.7	44.5
Other goods and services	267.3	269.3	271.7
Tobacco and smoking products	369.7	375.7	383.6
Personal care(1)	163.1	163.5	163.9
Personal Care products(1)	153.1	153.4	153.2
Personal care services(1)	174.7	175.3	176.1
Miscellaneous personal services	246.7	247.6	248.9
Commodity and service group:			
Commodities	146.6	146.6	147.8
Food and beverages	165.2	165.9	166.1
Commodities less food and beverages	135.4	135.1	136.8
Nondurables less food and beverages	142.0	141.7	145.1
Apparel	129.0	125.9	127.9
Nondurables less food, beverages, and apparel	153.9	155.0	159.3
Durables	126.3	126.0	125.6
Services	187.2	187.9	188.5
Rent of shelter(3)	176.5	177.3	178.0
Transportation services	189.9	190.2	190.8
Other services	222.9	223.8	223.7
Special indexes:			
All items less food	165.1	165.4	166.4
All items less shelter	160.1	160.3	161.3
All Items less medical care	161.1	161.4	162.3
Commodities less food	136.8	136.5	138.2
Nondurables less food	143.8	143.6	146.8
Nondurables less food and apparel	154.7	155.8	159.8
Nondurables	154.0	154.2	156.0
Services less rent of shelter(3)	175.9	176.4	176.9
Services less medical care services	181.2	181.9	182.4
Energy	112.1	112.5	116.7
All items less energy	172.5	172.8	173.3
All items less food and energy	174.5	174.8	175.3
Commodities less food and energy	144.6	144.1	144.6
Energy commodities	112.1	113.1	120.4
Services less energy	194.7	195.5	196.2

Series	2000 Mar.	Apr.	May
CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS			
All items	171.1	171.2	171.3
All items (1967 = 100)	512.5	512.9	513.3
Food and beverages	167.1	167.2	167.8
Food	166.5	166.6	167.3
Food at home	166.4	166.5	167.5
Cereals and bakery products	186.1	187.2	188.6
Meats, poultry, fish, and eggs	152.4	152.9	153.9
Dairy and related products(1)	159.1	160.6	159.6
Fruits and vegetables	201.7	201.6	204.3
Nonalcoholic beverages and beverage materials	138.5	137.6	137.3
Other foods at home	155.1	154.0	155.4
Sugar and sweets	154.6	152.4	153.7
Fats and oils	145.9	144.8	147.0
Other foods	171.6	170.7	172.1
Other miscellaneous foods(1,2)	107.0	105.2	106.4
Food away from home(1)	167.9	168.1	168.3
Other food away from home(1,2)	107.9	108.0	108.1
Alcoholic beverages	173.5	173.6	173.8
Housing	167.6	167.6	167.8
Shelter	191.8	191.8	192.0
Rent of primary residence	181.7	181.9	182.3
Lodging away from home	120.9	119.4	117.5
Owners' equivalent rent of primary residence(3)	196.4	196.8	197.2
Tenants' and household insurance(1,2)	102.6	103.1	103.8
Fuels and utilities	131.8	131.7	132.4
Fuels	116.3	116.1	116.8
Fuel oil and other fuels	130.1	123.7	121.6
Gas (piped) and electricity	120.7	121.0	122.0
Household furnishings and operations	127.9	128.2	128.1
Apparel	132.5	133.3	132.2
Men's and boys' apparel	131.5	131.6	132.6
Women's and girls' apparel	125.9	126.7	124.4
Infants' and toddlers' apparel(1)	133.9	132.3	131.7
Footwear	124.7	126.7	126 1
Transportation	153.4	152.9	153.1
Private transportation	149.2	148.7	148.8
New and used motor vehicles(2)	100.4	100.8	101.0
New vehicles	143.3	143.5	143.3
Used cars and trucks(1)	153.0	154.0	155.3
Motor fuel	131.7	128.7	128.3
Gasoline (all types)	130.9	127.9	127.6
Motor vehicle parts and equipment	101.4	101.0	101.1
Motor vehicle maintenance and repair	175.7	175.9	176.3
Public transportation	209.8	209.2	210.4
Medical care	258.1	258.8	259.4
Medical care commodities	236.3	237.0	237.5
Medical care services	236.2	263.9	264.4
Professional services	236.1	236.6	237.1
Hospital and related services	311.5	312.7	313.5
Recreation(2)	102.9	102.9	103.1

Video and audio(1,2)	100.9	100.3	101.3
Education and communication(2)	102.0	101.8	101.8
Education(2)	110.6	110.7	110.9
Educational books and supplies	276.9	276.7	276.8
Tuition, other school fees, and child care	318.3	318.7	319.2
Communication(1,2)	94.3	93.8	93.7
Information and information processing(1,2)	93.6	93.1	93.0
Telephone services(1,2)	98.9	98.6	98.5
Information and information processing other than telephone services(1,4)	27.2	26.7	26.6
Personal computers and peripheral equipment(1,2)	44.2	42.7	42.4
Other goods and services	268.0	271.9	270.2
Tobacco and smoking products	387.3	404.4	393.5
Personal care(1)	164.3	164.8	165.1
Personal Care products(1)	153.5	153.4	153.0
Personal care services(1)	176.2	176.2	177.3
Miscellaneous personal services	249.4	250.9	251.7
Commodity and service group:			
Commodities	149.2	149.3	149.2
Food and beverages	167.1	167.2	167.8
Commodities less food and beverages	138.4	138.4	138.0
Nondurables less food and beverages	148.5	148.5	147.6
Apparel	132.5	133.3	132.2
Nondurables less food, beverages, and apparel	162.7	162.3	161.5
Durables	125.6	125.8	125.8
Services	193.1	193.3	193.6
Rent of shelter(3)	199.7	199.8	199.9
Transportation services	195.0	195.2	195.7
Other services	227.8	228.0	228.4
Special indexes:			
All items less food	171.9	172.0	172.1
All items less shelter	164.8	164.9	165.1
All Items less medical care	168.3	166.4	166.5
Commodities less food	139.9	139.9	139.4
Nondurables less food	150.1	150.1	149.3
Nondurables less food and apparel	163.0	162.7	161.9
Nondurables	158.1	158.2	158.0
Services less rent of shelter(3)	199.9	200.2	200.9
Services less medical care services	186.7	186.9	187.2
Energy	122.2	120.7	121.0
All items less energy	177.7	178.0	178.1
All items less food and energy	180.4	180.7	180.8
Commodities less food and energy	145.3	145.9	145.5
Energy commodities	131.7	128.4	127.9
Services less energy	200.5	200.7	200.9

CONSUMER PRICE INDEX FOR URBAN
WAGE EARNERS AND CLERICAL WORKERS

All items	167.8	167.9	168.1
All items (1967 = 100)	499.7	500.1	500.7
Food and beverages	166.4	166.5	167.2
Food	165.9	166.0	166.7
Food at home	165.3	165.4	168.4

Cereals and bakery products	165.9	186.9	168.4
Meats, poultry, fish, and eggs	152.0	152.5	153.5
Dairy and related products(1)	158.7	160.2	159.3
Fruits and vegetables	200.5	200.5	203.1
Nonalcoholic beverages and beverage materials	137.8	136.7	136.4
Other foods at home	154.5	153.4	154.9
Sugar and sweets	154.5	152.3	153.6
Fats and oils	145.7	144.5	146.9
Other foods	171.6	170.7	172.2
Other miscellaneous foods(1,2)	106.7	104.7	106.1
Food away from home(1)	167.9	168.1	168.3
Other food away from home(1,2)	107.8	108.3	108.5
Alcoholic beverages	172.8	172.9	172.9
Housing	163.2	163.3	163.6
Shelter	165.6	185.8	186.1
Rent of primary residence	181.2	181.4	181.8
Lodging away from home(2)	119.9	118.7	117.8
Owners' equivalent rent of primary residence(3)	178.8	179.1	179.5
Tenants' and household insurance(1,2)	102.8	103.3	104.0
Fuels and utilities	131.2	131.1	131.9
Fuels	115.4	115.2	116.0
Fuel oil and other fuels	129.6	123.0	120.9
Gas (piped) and electricity	120.2	120.5	121.6
Household furnishings and operations	125.3	125.6	125.5
Apparel	131.0	131.8	130.9
Men's and boys' apparel	131.5	131.5	132.7
Women's and girls' apparel	123.5	124.3	122.1
Infants' and toddlers' apparel(1)	135.7	134.1	133.4
Footwear	124.7	127.1	126.8
Transportation	162.9	152.2	152.5
Private transportation	150.1	149.5	149.7
New and used motor vehicles(2)	100.8	101.2	101.5
New vehicles	144.5	144.7	144.5
Used cars and trucks(1)	154.4	155.4	156.8
Motor fuel	132.0	128.5	128.5
Gasoline (all types)	131.2	127.8	127.9
Motor vehicle parts and equipment	100.9	100.6	100.5
Motor vehicle maintenance and repair	177.2	177.4	177.8
Public transportation	203.4	202.9	203.9
Medical care	257.3	258.0	258.5
Medical care commodities	231.8	232.4	232.9
Medical care services	263.1	263.8	264.4
Professional services	238.0	238.6	239.0
Hospital and related services	307.5	308.7	309.5
Recreation(2)	102.0	102.0	12.3
Video and audio(1,2)	100.6	100.0	101.0
Education and communication(2)	102.2	102.1	102.1
Education(2)	111.0	111.1	111.3
Educational books and supplies	280.0	279.9	280.0
Tuition, other school fees, and child care	312.8	313.4	313.8
Communication(1,2)	95.3	94.8	94.7
Information and information processing(1,2)	94.8	94.4	94.3
Telephone services(1,2)	99.1	98.8	98.7
Information and information processing other than			

telephone services(1,4)	28.2	27.6	27.5
Personal computers and peripheral equipment(1,2)	43.6	42.0	41.8
Other goods and services	273.3	278.0	275.4
Tobacco and smoking products	387.8	404.9	393.7
Personal care(1)	164.3	164.6	164.9
Personal Care products(1)	154.1	153.9	153.4
Personal care services(1)	176.6	176.6	177.7
Miscellaneous personal services	249.4	250.4	251.2
Commodity and service group:			
Commodities	149.8	149.9	149.9
Food and beverages	166.4	166.5	167.2
Commodities less food and beverages	139.6	139.6	139.3
Nondurables less food and beverages	150.2	150.2	149.4
Apparel	131.0	131.8	130.9
Nondurables less food, beverages, and apparel	165.7	165.2	164.4
Durables	125.8	126.0	126.2
Services	189.2	189.4	189.8
Rent of shelter(3)	178.7	178.9	179.2
Transportation services	191.8	192.0	192.4
Other services	224.0	224.2	224.6
Special indexes:			
All items less food	168.0	168.2	168.3
All items less shelter	162.8	163.0	163.1
All Items less medical care	163.6	163.8	164.0
Commodities less food	141.0	141.0	140.7
Nondurables less food	151.7	151.7	150.9
Nondurables less food and apparel	165.7	165.3	164.5
Nondurables	158.8	158.9	158.8
Services less rent of shelter(3)	177.4	177.7	178.2
Services less medical care services	183.1	183.3	183.7
Energy	122.9	121.0	121.5
All items less energy	174.1	174.5	174.6
All items less food and energy	176.2	176.7	176.7
Commodities less food and energy	145.6	146.4	146.0
Energy commodities	132.0	128.3	128.3
Services less energy	196.9	197.1	197.5

Series	2000		
	June	July	Aug.
CONSUMER PRICE INDEX FOR ALL URBAN CONSUMERS			
All items	172.3	172.8	172.7
All items (1967 = 100)	516.1	517.2	517.2
Food and beverages	167.9	168.7	169.2
Food	167.3	168.1	168.7
Food at home	167.3	168.3	168.9
Cereals and bakery products	187.7	189.6	189.9
Meats, poultry, fish, and eggs	154.9	155.8	156.8
Dairy and related products(1)	159.5	160.5	161.0
Fruits and vegetables	199.9	201.0	202.5
Nonalcoholic beverages and beverage materials	137.5	138.5	138.2
Other foods at home	156.2	156.6	156.9
Sugar and sweets	154.0	154.1	154.6

Fats and oils	146.6	148.1	148.9
Other foods	173.4	173.5	173.7
Other miscellaneous foods(1,2)	108.4	108.8	109.5
Food away from home(1)	168.6	169.1	169.5
Other food away from home(1,2)	108.1	108.7	109.3
Alcoholic beverages	174.4	175.2	175.6
Housing	169.4	170.4	170.7
Shelter	192.9	193.7	194.3
Rent of primary residence	182.8	183.5	164.2
Lodging away from home	120.5	122.8	123.0
Owners' equivalent rent of primary residence(3)	197.7	198.2	198.8
Tenants' and household insurance(1,2)	103.9	104.2	104.0
Fuels and utilities	138.9	141.3	140.9
Fuels	124.0	126.5	125.9
Fuel oil and other fuels	120.9	120.8	120.8
Gas (piped) and electricity	130.2	133.0	132.4
Household furnishings and operations	128.1	128.6	128.6
Apparel	128.3	124.5	125.3
Men's and boys' apparel	129.4	126.4	126.8
Women's and girls' apparel	119.2	113.9	115.8
Infants' and toddlers' apparel(1)	130.5	128.1	126.7
Footwear	123.9	120.3	120.7
Transportation	155.7	155.0	153.2
Private transportation	151.4	150.6	148.6
New and used motor vehicles(2)	100.8	100.6	100.4
New vehicles	142.9	142.5	141.9
Used cars and trucks(1)	155.2	155.3	155.2
Motor fuel	139.0	136.1	128.4
Gasoline (all types)	138.3	135.4	127.7
Motor vehicle parts and equipment	101.2	101.5	101.5
Motor vehicle maintenance and repair	176.8	177.2	178.2
Public transportation	212.6	213.7	215.7
Medical care	260.5	261.4	282.6
Medical care commodities	238.2	238.6	239.2
Medical care services	265.6	266.7	268.0
Professional services	237.9	238.3	238.9
Hospital and related services	315.6	318.1	321.3
Recreation(2)	103.4	103.7	193.9
Video and audio(1,2)	101.5	101.3	101.6
Education and communication(2)	101.5	102.0	102.8
Education(2)	111.5	111.8	113.0
Educational books and supplies	277.5	278.1	280.2
Tuition, other school fees, and child care	320.9	321.7	325.4
Communication(1,2)	92.6	93.3	93.7
Information and information processing(1,2)	91.8	92.5	93.0
Telephone services(1,2)	97.2	98.2	98.9
Information and information processing other than telephone services(1,4)	26.0	25.7	25.2
Personal computers and peripheral equipment(1,2)	41.2	40.3	39.5
Other goods and services	269.6	272.2	271.6
Tobacco and smoking products	368.5	400.7	394.1
Personal care(1)	165.4	165.7	165.2
Personal Care products(1)	153.8	153.7	154.3
Personal care services(1)	177.9	178.2	179.3

Miscellaneous personal services	252.0	252.9	253.6
Commodity and service group:			
Commodities	149.7	149.3	148.6
Food and beverages	167.9	168.7	169.2
Commodities less food and beverages	138.6	137.7	136.4
Nondurables less food and beverages	149.1	147.5	145.6
Apparel	128.3	124.5	125.3
Nondurables less food, beverages, and apparel	165.8	165.4	162.0
Durables	125.4	125.2	124.7
Services	195.0	196.1	196.7
Rent of shelter(3)	200.8	201.7	202.3
Transportation services	196.1	196.5	197.4
Other services	228.7	229.9	231.3
Special indexes:			
All items less food	173.2	173.5	173.4
All items less shelter	166.0	166.2	166.0
All Items less medical care	167.5	167.8	167.8
Commodities less food	140.1	139.2	138.0
Nondurables less food	150.7	149.3	147.5
Nondurables less food and apparel	166.0	165.7	162.6
Nondurables	158.8	158.4	157.6
Services less rent of shelter(3)	202.9	204.2	205.0
Services less medical care services	188.6	189.6	190.3
Energy	129.6	129.7	125.9
All items less energy	178.2	178.5	179.0
All items less food and energy	180.8	181.1	181.6
Commodities less food and energy	144.5	143.8	143.7
Energy commodities	137.6	135.0	127.9
Services less energy	201.6	202.5	203.3

CONSUMER PRICE INDEX FOR URBAN
WAGE EARNERS AND CLERICAL WORKERS

All items	169.1	169.3	169.2
All items (1967 = 100)	503.8	504.4	503.9
Food and beverages	167.3	168.0	168.6
Food	166.8	167.6	168.1
Food at home	168.3	167.3	167.9
Cereals and bakery products	187.3	189.2	189.5
Meats, poultry, fish, and eggs	154.6	155.4	156.5
Dairy and related products(1)	159.4	160.5	160.9
Fruits and vegetables	198.9	200.0	201.5
Nonalcoholic beverages and beverage materials	136.7	137.5	137.4
Other foods at home	155.6	156.0	156.2
Sugar and sweets	153.9	154.2	154.4
Fats and oils	146.4	147.9	148.6
Other foods	173.4	173.5	173.6
Other miscellaneous foods(1,2)	108.0	108.4	109.0
Food away from home(1)	168.6	169.1	169.5
Other food away from home(1,2)	108.4	108.8	109.6
Alcoholic beverages	173.6	174.4	174.7
Housing	165.2	156.1	166.3
Shelter	186.8	187.5	168.0
Rent of primary residence	182.3	183.1	183.7
Lodging away from home(2)	120.9	123.1	122.5
Owners' equivalent rent of primary residence(3)	180.0	180.4	180.9

Tenants' and household insurance(1,2)	104.1	104.4	104.2
Fuels and utilities	138.7	141.0	140.4
Fuels	123.3	125.7	125.0
Fuel oil and other fuels	120.2	120.1	120.1
Gas (piped) and electricity	129.9	132.5	131.8
Household furnishings and operations	125.3	125.7	125.7
Apparel	127.3	123.6	124.0
Men's and boys' apparel	129.5	126.6	126.8
Women's and girls' apparel	117.4	112.2	113.2
Infants' and toddlers' apparel(1)	132.0	129.8	128.4
Footwear	124.6	120.9	121.5
Transportation	155.5	154.4	152.3
Private transportation	152.8	151.6	149.3
New and used motor vehicles(2)	101.4	101.1	100.9
New vehicles	141.1	143.7	143.1
Used cars and trucks(1)	157.1	156.6	156.5
Motor fuel	140.1	136.2	128.0
Gasoline (all types)	139.4	135.5	127.3
Motor vehicle parts and equipment	100.5	100.8	100.7
Motor vehicle maintenance and repair	178.3	178.7	179.6
Public transportation	205.5	206.9	208.7
Medical care	259.7	260.6	261.7
Medical care commodities	233.7	234.2	234.6
Medical care services	265.6	266.6	267.9
Professional services	239.9	240.3	240.9
Hospital and related services	311.7	314.2	317.1
Recreation(2)	102.5	102.7	102.9
Video and audio(1,2)	101.2	100.9	101.3
Education and communication(2)	101.7	102.2	103.0
Education(2)	111.8	112.1	113.2
Educational books and supplies	280.9	281.5	283.6
Tuition, other school fees, and child care	315.4	316.2	319.2
Communication(1,2)	93.6	94.3	94.8
Information and information processing(1,2)	93.0	93.9	94.4
Telephone services(1,2)	97.4	98.4	99.1
Information and information processing other than telephone services(1,4)	27.0	26.6	26.1
Personal computers and peripheral equipment(1,2)	40.7	39.8	39.1
Other goods and services	274.5	277.9	276.8
Tobacco and smoking products	388.7	400.9	394.2
Personal care(1)	165.3	165.5	166.1
Personal Care products(1)	154.0	154.1	155.0
Personal care services(1)	178.3	178.6	179.7
Miscellaneous personal services	251.4	252.2	253.0
Commodity and service group:			
Commodities	150.6	151.1	149.3
Food and beverages	167.3	168.0	168.6
Commodities less food and beverages	140.3	139.2	137.7
Nondurables less food and beverages	151.5	149.7	147.2
Apparel	127.3	123.6	124.0
Nondurables less food, beverages, and apparel	169.6	168.7	164.6
Durables	125.9	125.6	125.2
Services	191.2	192.2	192.8

Rent of shelter(3)	179.9	180.6	181.1
Transportation services	192.6	193.0	193.8
Other services	224.7	225.9	227.3
Special indexes:			
All items less food	169.5	169.6	169.2
All items less shelter	164.3	164.3	163.9
All Items less medical care	165.0	165.1	164.9
Commodities less food	141.7	140.6	139.1
Nondurables less food	152.9	151.2	148.9
Nondurables less food and apparel	169.4	168.7	164.9
Nondurables	159.9	159.4	158.3
Services less rent of shelter(3)	180.2	181.3	181.9
Services less medical care services	185.1	186.0	186.6
Energy	130.9	130.1	125.7
All items less energy	174.6	174.9	175.3
All items less food and energy	176.6	176.8	177.2
Commodities less food and energy	145.0	144.5	144.2
Energy commodities	139.1	135.4	127.7
Services less energy	198.0	198.8	199.5

(1) Not seasonally adjusted.
(2) Indexes on a December 1997 = 100 base.
(3) Indexes on a December 1982 = 100 base.
(4) indexes on a December 1968 = 100 base.
-- Data not available.
NOTE: Index applies to a month as a whole, not to any specific, date.

29. Consumer Price Index: U.S. city average and available local area data: all items
(1982-84 = 100, unless otherwise indicated)

Area	Pricing sched-ule(1)	All Urban Consumers 1999 July	Aug.
U.S. city average	M	166.7	167.1
Region and area size(2)			
Northeast urban	M	173.4	174.1
Size A--More than 1,500,000	M	174.5	175.1
Size B/C--50,000 to 1,500,000(3)	M	103.9	104.3
Midwest urban(4)	M	162.9	163.2
Size A--More than 1,500,000	M	164.6	164.8
Size B/C-50,000 to 1,500,000(3)	M	103.9	104.2
Size D--Nonmetropolitan (less than 50,000)	M	157.2	157.7
South urban	M	162.2	162.6
Size A--More than 1,500,000	M	161.4	161.9
Size B/C--50,000 to 1,500,000(3)	M	104.3	104.4
Size D--Nonmetropolitan (less than 50,000)	M	162.6	163.7
West urban	M	168.9	169.5
Size A--More than 1,500,000	M	169.9	170.5

Size B/C--50,000 to 1,500,0003	M	104.9	105.2
Size classes:			
A(5)	M	151.1	151.6
B/C(3)	M	104.2	104.5
D	M	162.4	163.1
Selected local areas(6)			
Chicago-Gary-Kenosha, IL-IN-WI	M	169.4	169.3
Los Angeles-Riverside-Orange County, CA	M	165.8	166.3
New York, NY-Northern NJ-Long Island, NY-NJ-CT-PA	M	177.2	177.6
Boston-Brockton-Nashua, MA-NH-ME-CT	1	175.3	--
Cleveland--Akron, OH	1	162.8	--
Dallas-Ft Worth, TX	1	158.3	--
Washington-Baltimore, DC--MD-VA-WV7	1	104.6	--
Atlanta, GA	2	--	165.9
Detroit-Ann Arbor-Flint, MI	2	--	164.2
Houston-Galveston-Brazoria, TX	2	--	148.9
Miami-Ft. Lauderdale, FL	2	--	162.3
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	2	--	173.1
San Francisco--Oakland-San Jose, CA	2	--	173.5
Seattle--Tacoma--Bremerton, WA	2	--	173.4

Area	All Urban Consumers 2000 Apr.	May	June
U.S. city average	171.2	171.3	172.3
Region and area size(2)			
Northeast urban	178.4	178.2	178.8
Size A--More than 1,500,000	179.1	179.0	179.6
Size B/C--50,000 to 1,500,000(3)	107.4	107.3	107.6
Midwest urban(4)	166.9	167.4	169.5
Size A--More than 1,500,000	168.2	169.0	171.2
Size B/C-50,000 to 1,500,000(3)	106.8	106.9	108.3
Size D--Nonmetropolitan (less than 50,000)	161.3	161.4	163.1
South urban	166.6	166.6	167.4
Size A--More than 1,500,000	166.1	188.1	167.1
Size B/C--50,000 to 1,500,000(3)	107.1	107.1	107.6
Size D--Nonmetropolitan (less than 50,000)	166.7	167.0	166.9
West urban	173.7	173.9	174.3
Size A--More than 1,500,000	175.1	175.4	175.7

Size B/C--50,000 to 1,500,0003	107.2	107.3	107.6
Size classes:			
A(5)	155.2	155.4	156.3
B/C(3)	107.1	107.1	107.7
D	166.7	166.8	187.4
Selected local areas(6)			
Chicago-Gary-Kenosha, IL-IN-WI	171.7	173.5	175.8
Los Angeles-Riverside-Orange County, CA	170.6	171.1	170.9
New York, NY-Northern NJ-Long Island, NY-NJ-CT-PA	181.2	181.3	181.9
Boston-Brockton-Nashua, MA-NH-ME-CT	--	181.6	--
Cleveland--Akron, OH	--	166.4	--
Dallas-Ft Worth, TX	--	163.2	--
Washington-Baltimore, DC--MD-VA-WV7	--	106.7	--
Atlanta, GA	169.8	--	171.1
Detroit-Ann Arbor-Flint, MI	168.1	--	170.8
Houston-Galveston-Brazoria, TX	152.7	--	154.0
Miami-Ft. Lauderdale, FL	166.9	--	168.0
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	175.7	--	176.4
San Francisco--Oakland-San Jose, CA	178.6	--	179.0
Seattle--Tacoma--Bremerton, WA	177.7	--	179.1

Area	All Urban Consumers 2000 July	Aug.
U.S. city average	172.6	
Region and area size(2)		
Northeast urban	179.6	179.7
Size A--More than 1,500,000	180.4	180.7
Size B/C--50,000 to 1,500,000(3)	108.1	107.8
Midwest urban(4)	168.7	168.1
Size A--More than 1,500,000	170.3	169.9
Size B/C-50,000 to 1,500,000(3)	107.6	107.0
Size D--Nonmetropolitan (less than 50,000)	163.1	182.4
South urban	167.9	167.9
Size A--More than 1,500,000	167.8	167.8
Size B/C--50,000 to 1,500,000(3)	107.7	107.7
Size D--Nonmetropolitan (less than 50,000)	167.6	167.7
West urban	175.2	175.8
Size A--More than 1,500,000	176.7	177.6
Size B/C--50,000		

to 1,500,0003	108.1	108.3
Size classes:		
A(5)	156.7	156.9
B/C(3)	107.8	107.7
D	167.7	167.6
Selected local areas(6)		
Chicago-Gary-Kenosha, IL-IN-WI	174.4	173.5
Los Angeles-Riverside-Orange County, CA	171.7	172.2
New York, NY-Northern NJ-Long Island, NY-NJ-CT-PA	182.7	183.0
Boston-Brockton-Nashua, MA-NH-ME-CT	183.2	--
Cleveland--Akron, OH	168.1	--
Dallas-Ft Worth, TX	166.2	--
Washington-Baltimore, DC--MD-VA-WV7	108.4	--
Atlanta, GA	--	171.9
Detroit-Ann Arbor-Flint, MI	--	170.0
Houston-Galveston-Brazoria, TX	--	154.3
Miami-Ft. Lauderdale, FL	--	168.4
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	--	177.4
San Francisco--Oakland-San Jose, CA	--	181.7
Seattle--Tacoma--Bremerton, WA	--	180.2

Area	Urban Wage Earners			
	1999		2000	
	July	Aug.	Apr.	May
U.S. city average	163.3	163.8	167.9	168.1
Region and area size(2)				
Northeast urban	170.2	170.9	175.3	175.3
Size A--More than 1,500,000	170.3	171.0	175.0	175.0
Size B/C--50,000 to 1,500,000(3)	103.4	103.8	107.(	106.9
Midwest urban(4)	159.1	159.4	163.2	163.8
Size A--More than 1,500,000	159.9	160.2	163.6	64.51
Size B/C-50,000 to 1,500,000(3)	103.8	104.0	106.9	107.0
Size D--Nonmetropolitan (less than 50,000)	155.4	156.1	159.9	180.0
South urban	160.1	160.6	164.9	164.9
Size A--More than 1,500,000	158.9	159.5	163.7	163.7
Size B/C--50,000 to 1,500,000(3)	103.9	104.0	106.9	107.0
Size D--Nonmetropolitan (less than 50,000)	163.0	164.1	167.6	167.9
West urban	164.7	185.3	169.4	169.6
Size A--More than 1,500,000	164.0	164.7	189.0	189.3
Size B/C--50,000				

to 1,500,0003	104.7	105.1	107.1	107.1
Size classes:				
A(5)	149.6	150.1	153.7	154.0
B/C(3)	103.9	104.1	106.9	107.0
D	161.3	162.1	186.0	166.1
Selected local areas(6)				
Chicago-Gary-Kenosha, IL-IN-WI	163.4	635.0	166.1	167.9
Los Angeles-Riverside-Orange County, CA	159.2	159.8	163.9	164.4
New York, NY-Northern NJ-Long Island, NY-NJ-CT-PA	172.5	173.2	176.6	176.9
Boston-Brockton-Nashua, MA-NH-ME-CT	173.3	--	--	180.5
Cleveland--Akron, OH	154.9	--	--	158.9
Dallas-Ft Worth, TX	158.0	--	--	163.1
Washington-Baltimore, DC--MD-VA-WV7	104.3	--	--	106.6
Atlanta, GA	--	163.2	167.2	--
Detroit-Ann Arbor-Flint, MI	--	158.7	162.8	--
Houston-Galveston-Brazoria, TX	--	147.9	151.3	--
Miami-Ft. Lauderdale, FL	--	160.0	164.5	--
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	--	172.6	175.7	--
San Francisco--Oakland-San Jose, CA	--	170.0	174.8	--
Seattle--Tacoma--Bremerton, WA	--	168.8	173.2	--

Area	Urban Wage Earners 2000 June	July	Aug.
U.S. city average	169.1	169.3	169.2
Region and area size(2)			
Northeast urban	175.8	176.6	176.5
Size A--More than 1,500,000	175.5	176.4	176.5
Size B/C--50,000 to 1,500,000(3)	107.2	107.6	107.3
Midwest urban(4)	166.1	165.0	164.2
Size A--More than 1,500,000	166.8	165.7	165.2
Size B/C-50,000 to 1,500,000(3)	108.6	107.6	106.8
Size D--Nonmetropolitan (less than 50,000)	161.7	161.6	160.9
South urban	185.7	166.2	168.0
Size A--More than 1,500,000	164.9	165.6	165.4
Size B/C--50,000 to 1,500,000(3)	107.4	107.6	107.5
Size D--Nonmetropolitan (less than 50,000)	168.0	168.5	168.6
West urban	169.9	170.7	171.2
Size A--More than 1,500,000	169.6	170.6	171.2
Size B/C--50,000 to 1,500,0003	107.4	107.9	108.0

Size classes:			
A(5)	155.0	155.3	155.3
B/C(3)	107.6	107.6	107.3
D	166.6	166.9	166.7
Selected local areas(6)			
Chicago-Gary-Kenosha, IL-IN-WI	170.2	168.7	167.8
Los Angeles-Riverside-Orange County, CA	164.2	164.9	165.2
New York, NY-Northern NJ-Long Island, NY-NJ-CT-PA	177.4	178.2	178.4
Boston-Brockton-Nashua, MA-NH-ME-CT	--	182.2	--
Cleveland--Akron, OH	--	160.4	--
Dallas-Ft Worth, TX	--	166.2	--
Washington-Baltimore, DC--MD-VA-WV7	--	108.2	--
Atlanta, GA	168.7	--	169.4
Detroit-Ann Arbor-Flint, MI	165.6	--	164.4
Houston-Galveston-Brazoria, TX	153.0	--	153.0
Miami-Ft. Lauderdale, FL	185.7	--	165.7
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	176.0	--	177.0
San Francisco--Oakland-San Jose, CA	175.2	--	177.7
Seattle--Tacoma--Bremerton, WA	174.4	--	175.3

(1) Foods, fuels, and several other items priced every month in all areas; most other goods and services priced as indicated:

M--Every month.

1--January, March, May, July, September, and November. 2--February, April, June, August, October, and December.

(2) Regions defined as the four Census regions.

(3) Indexes on a December 1996 = 100 base.

(4) The "North Central" region has been renamed the "Midwest" region by the Census Bureau.

It is composed of the same geographic entities.

(5) Indexes on a December 1986 = 100 base.

(6) In addition, the following metropolitan areas are published semiannually and appear in tables 34 and 39 of the January and July issues of the cPI Detailed Report: Anchorage, AK; Cincinnati-Hamilton, OH-KY-IN; Denver-Boulder-Greeley, CO; Honolulu, HI; Kansas City, MO-KS; Milwaukee-Racine, WI; Minneapolis-St. Paul, MN-WI; Pittsburgh, PA; Portland-Salem, OR-WA; St. Louis, MO-IL; San Diego, CA; Tampa-St. Petersburg-Clearwater, FL.

(7) indexes on a November 1996 ,= 100 base.

-- Data not available.

NOTE: Local area CPI indexes are by products of the national CPI program. Each local index has a smaller sample size and is, therefore, subject to substantially more sampling and other measurement error. As a result, local area indexes show greater volatility than the national index, although their long-term trends are similar. Therefore, the Bureau of Labor Statistics strongly urges users to consider adopting the national average CPI for use in their escalator clauses. Index applies to a month as a whole, not to any specific date.

30. Annual data: Consumer Price Index, U.S. city average, all item and major groups

(1982-84 = 100)

Series	1991	1992	1993	1994	1995
Consumer Price Index for					

All Urban Consumers:					
All items:					
Index	136.2	140.3	144.5	148.2	152.4
Percent change	4.2	3.0	2.6	2.6	2.8
Food and beverages					
Index	136.8	138.7	144.9	144.9	148.9
Percent change	3.6	1.4	2.3	2.3	2.8
Housing:					
Index	133.6	137.5	141.2	144.8	148.5
Percent change	4.0	2.9	2.5	2.5	2.6
Apparel:					
Index	128.7	131.9	133.7	133.4	132.0
Percent change	3.7	2.5	1.4	-.2	-1.0
Transportation:					
Index	123.8	126.5	130.4	134.3	139.1
Percent change	2.7	2.2	3.1	3.0	3.6
Medical care:					
Index	177.0	190.1	201.4	211.0	220.5
Percent change	8.7	7.4	5.9	4.8	4.5
Other goods and services:					
Index	171.6	183.3	192.9	198.5	206.9
Percent change	7.9	6.8	5.2	2.9	4.2
Consumer Price Index for Urban Wage Earners and Clerical Workers:					
All items:					
Index	134.3	138.2	142.1	145.6	149.8
Percent change	4.1	2.9	2.8	2.5	2.9

Series	1996	1997	1998	1999
Consumer Price Index for All Urban Consumers:				
All items:				
Index	156.9	160.5	163.0	166.6
Percent change	3.0	2.3	1.6	2.2
Food and beverages				
Index	153.7	157.7	161.1	164.6
Percent change	3.2	2.6	2.2	2.2
Housing:				
Index	152.8	156.8	160.4	163.9
Percent change	2.9	2.6	2.3	2.2
Apparel:				
Index	131.7	132.9	133.0	131.3
Percent change	-.2	.9	.1	-1.3
Transportation:				
Index	143.0	144.3	141.6	144.4
Percent change	2.8	0.9	-1.9	2.0
Medical care:				
Index	228.2	234.6	242.1	250.6
Percent change	3.5	2.8	3.2	3.5
Other goods and services:				
Index	215.4	224.8	237.7	258.3
Percent change	4.1	4.4	5.7	8.7
Consumer Price Index for Urban Wage Earners and Clerical Workers:				
All items:				

Index	154.1	157.6	159.7	163.2
Percent change	2.9	2.3	1.3	2.2

31. Producer Price Indexes, by stage of processing
(1982 = 100)

Grouping	Annual average 1998	Annual average 1999	1999 Aug.	1999 Sept.
Finished goods	130.7	133.0	133.7	134.7
Finished consumer goods	128.9	132.0	133.2	134.6
Finished consumer foods	134.3	135.1	135.9	136.7
Finished consumer goods excluding foods	126.4	130.5	131.9	133.5
Nondurable goods less food	122.2	127.9	130.4	132.8
Durable goods	132.9	133.0	131.8	131.2
Capital equipment	137.6	137.6	136.9	136.7
Intermediate materials, supplies, and components	123.0	123.2	124.6	125.3
Materials and components for manufacturing	126.1	124.6	125.0	125.4
Materials for food manufacturing	123.2	120.8	121.1	122.0
Materials for nondurable manufacturing	126.7	124.9	125.5	126.5
Materials for durable manufacturing	128.0	125.1	126.2	126.2
Components for manufacturing	125.9	125.7	125.6	125.7
Materials and components for construction	146.8	148.9	150.4	149.6
Processed fuels and lubricants	81.1	84.6	90.0	92.5
Containers	140.8	142.5	143.6	145.7
Supplies	134.8	134.2	134.2	134.4
Crude materials for further processing	96.8	98.2	103.1	107.3
Foodstuffs and feedstuffs	103.9	98.7	100.1	100.1
Crude nonfood materials	88.4	943.0	101.5	108.3
Special groupings:				
Finished goods, excluding foods	129.5	132.3	133.0	134.0
Finished energy goods	75.1	78.8	83.5	85.8
Finished goods less energy	141.1	143.0	142.5	143.1
Finished consumer goods less energy	142.5	145.2	144.9	145.8
Finished goods less food and energy	143.7	146.1	145.2	145.7
Finished consumer goods less food and energy	147.7	151.7	150.7	151.7
Consumer nondurable goods less food and energy	159.1	166.3	165.7	167.9
Intermediate materials				

less foods and feeds	123.4	123.9	125.4	126.0
Intermediate foods and feeds	116.2	111.1	110.9	111.8
Intermediate energy goods	80.8	84.6	89.6	92.1
Intermediate goods less energy	132.4	131.7	132.3	132.5
Intermediate materials less foods and energy	133.5	133.1	133.7	133.9
Crude energy materials	68.6	78.5	87.3	95.4
Crude materials less energy	113.6	107.9	109.4	110.0
Crude nonfood materials less energy	142.1	135.2	136.8	139.1

Grouping	1999			2000
	Oct.	Nov.	Dec.	Jan.
Finished goods	135.1	134.9	134.9	134.7
Finished consumer goods	134.5	134.3	134.3	133.9
Finished consumer foods	135.8	135.4	135.6	135.0
Finished consumer goods excluding foods	133.7	133.6	133.6	133.3
Nondurable goods less food	131.5	131.6	131.7	131.4
Durable goods	134.9	134.6	134.4	134.1
Capital equipment	138.5	138.3	138.3	138.4
Intermediate materials, supplies, and components	125.0	125.2	125.4	125.9
Materials and components for manufacturing	125.9	125.9	125.9	128.4
Materials for food manufacturing	122.2	120.9	118.2	117.6
Materials for nondurable manufacturing	127.7	127.8	128.2	128.6
Materials for durable manufacturing	126.5	126.7	127.2	128.6
Components for manufacturing	125.7	125.7	125.8	125.9
Materials and components for construction	149.1	149.4	149.8	150.4
Processed fuels and lubricants	89.3	90.2	906.0	91.5
Containers	146.3	146.5	146.5	147.2
Supplies	134.8	135.0	135.1	135.2
Crude materials for further processing	104.0	109.2	103.5	105.8
Foodstuffs and feedstuffs	98.8I	99.5	96.9	96.5
Crude nonfood materials	103.8	111.9	104.3	108.3
Special groupings:				
Finished goods, excluding foods	134.7	134.7	134.6	134.5
Finished energy goods	83.5	83.6	83.6	83.8
Finished goods less energy	144.2	144.0	144.0	143.6
Finished consumer goods less energy	146.6	146.3	146.4	145.8
Finished goods less				

food and energy	147.5	147.4	147.4	147.0
Finished consumer goods less food and energy	153.6	153.4	153.4	152.8
Consumer nondurable goods less food and energy	168.1	168.2	168.2	167.3
Intermediate materials less foods and feeds	125.7	126.0	126.2	126.8
Intermediate foods and feeds	112.4	111.6	109.7	109.3
Intermediate energy goods	890.0	89.9	90.3	91.2
Intermediate goods less energy	132.9	133.0	133.0	133.5
Intermediate materials less foods and energy	134.2	134.4	134.6	135.1
Crude energy materials	88.7	98.9	87.9	92.0
Crude materials less energy	109.8	110.5	109.5	110.2
Crude nonfood materials less energy	141.7	142.6	146.0	149.8

Grouping	2000			
	Feb.	Mar.	Apr.	May
Finished goods	136.0	136.8	136.7	137.5
Finished consumer goods	135.7	136.7	136.5	137.6
Finished consumer foods	136.0	136.0	137.3	138.0
Finished consumer goods excluding foods	135.4	136.8	136.0	137.2
Nondurable goods less food	134.3	136.4	135.3	136.9
Durable goods	133.9	133.8	133.9	134.0
Capital equipment	138.5	138.5	138.5	138.7
Intermediate materials, supplies, and components	126.9	127.8	128.0	128.3
Materials and components for manufacturing	127.0	127.6	128.2	128.4
Materials for food manufacturing	117.5	118.1	119.6	120.6
Materials for nondurable manufacturing	129.7	131.3	132.3	133.2
Materials for durable manufacturing	129.6	129.7	130.0	129.6
Components for manufacturing	125.9	126.0	1261.0	126.0
Materials and components for construction	150.8	151.3	151.6	151.1
Processed fuels and lubricants	948.0	97.4	95.7	96.7
Containers	147.2	148.1	151.6	152.8
Supplies	135.6	136.0	136.4	136.6
Crude materials for further processing	110.3	112.9	111.3	115.4
Foodstuffs and feedstuffs	97.6	101.4	103.4	104.6
Crude nonfood materials	115.1	116.7	112.7	118.6

Special groupings:				
Finished goods, excluding foods	135.9	136.9	136.4	137.2
Finished energy goods	87.5	90.9	89.2	91.5
Finished goods less energy	144.3	144.3	144.6	145.0
Finished consumer goods less energy	146.7	146.7	147.2	147.6
Finished goods less food and energy	147.5	147.5	147.5	147.8
Finished consumer goods less food and energy	153.6	153.6	153.5	153.8
Consumer nondurable goods less food and energy	169.0	169.1	168.9	169.4
Intermediate materials less foods and feeds	127.8	128.8	128.9	129.2
Intermediate foods and feeds	110.0	111.0	111.9	113.2
Intermediate energy goods	94.5	97.1	95.4	96.5
Intermediate goods less energy	133.9	134.5	135.1	135.2
Intermediate materials less foods and energy	135.5	136.1	136.6	136.7
Crude energy materials	100.2	102.5	97.9	105.8
Crude materials less energy	111.5	114.1	115.1	115.8
Crude nonfood materials less energy	151.3	150.9	149.2	148.5

Grouping	2000		
	June	July	Aug.
Finished goods	138.4	138.3	138.1
Finished consumer goods	138.8	138.6	138.5
Finished consumer foods	137.3	137.4	136.9
Finished consumer goods excluding foods	139.2	139.0	139.0
Nondurable goods less food	139.9	139.7	139.9
Durable goods	133.6	133.2	132.7
Capital equipment	138.5	138.6	138.4
Intermediate materials, supplies, and components	129.7	130.1	129.9
Materials and components for manufacturing	128.6	129.0	128.6
Materials for food manufacturing	120.7	120.5	119.1
Materials for nondurable manufacturing	133.9	135.0	134.2
Materials for durable manufacturing	129.3	129.3	129.1
Components for manufacturing	126.1	126.2	126.2
Materials and components for construction	150.9	150.5	150.3
Processed fuels			

and lubricants	103.2	103.9	104.6
Containers	153.3	153.3	153.1
Supplies	137.1	137.3	136.9
Crude materials for further processing	121.9	120.8	1192.0
Foodstuffs and feedstuffs	101.8	99.4	954.0
Crude nonfood materials	131.4	131.1	131.2
Special groupings:			
Finished goods, excluding foods	138.6	138.4	138.4
Finished energy goods	97.0	96.2	963.0
Finished goods less energy	144.6	144.7	144.5
Finished consumer goods less energy	147.1	147.2	147.0
Finished goods less food and energy	147.5	147.5	147.4
Finished consumer goods less food and energy	153.4	153.5	153.4
Consumer nondurable goods less food and energy	169.0	169.4	169.8
Intermediate materials less foods and feeds	130.7	131.0	131.0
Intermediate foods and feeds	113.5	112.7	110.2
Intermediate energy goods	102.9	103.6	104.3
Intermediate goods less energy	135.5	135.7	135.3
Intermediate materials less foods and energy	136.9	137.2	137.0
Crude energy materials	122.9	123.4	124.2
Crude materials less energy	113.3	110.9	107.4
Crude nonfood materials less energy	146.8	144.2	142.3

32. Producer Price Indexes for the net output of major industry groups

(December 1984 = 100, unless otherwise indicated)

SIC	Industry	1998	1999	1999 Aug.	1999 Sept.
--	Total mining Industries	70.8	78.0	84.7	91.5
10	Metal mining	73.2	70.3	69.3	70.4
12	Coal mining (12/85 = 100)	89.5	87.3	86.9	85.9
13	Oil and gas extraction (12/85 = 100)	68.3	78.5	87.6	96.9
14	Mining and quarrying of nonmetallic minerals, except fuels	132.2	134.0	134.2	134.3
--	Total manufacturing Industries	126.2	128.3	129.0	129.7
20	Food and kindred products	126.3	126.3	126.8	127.5
21	Tobacco manufactures	243.1	325.7	316.5	344.5
22	Textile mill products	118.6	116.3	116.0	115.9
23	Apparel and other				

	finished products made from fabrics and similar materials	124.8	125.3	125.5	125.6
24	Lumber and wood products, except furniture	157.0	161.8	166.9	163.1
25	Furniture and fixtures	139.7	141.3	141.6	141.8
26	Paper and allied products	136.2	136.4	137.3	138.7
27	Printing, publishing, and allied industries	174.0	177.6	177.7	178.1
28	Chemicals and allied products	148.7	149.7	150.0	151.0
29	Petroleum refining and related products	68.3	76.8	853.0	90.2
30	Rubber and miscellaneous plastics products	122.1	122.2	122.5	122.8
31	Leather and leather products	137.1	136.5	136.7	136.9
32	Stone, clay, glass, and concrete products	129.3	132.6	133.1	133.2
33	Primary metal industries	120.9	115.8	115.7	116.4
34	Fabricated metal products, except machinery and transportation equipment	128.7	1291.0	129.1	129.2
35	Machinery, except electrical	117.7	117.3	117.2	117.1
36	Electrical and electronic machinery, equipment, and supplies	110.4	109.5	109.5	109.2
37	Transportation	133.6	134.5	132.9	132.6
38	Measuring and controlling instruments; photo-graphic, medical, and optical goods; watches and clocks	126.0	125.7	125.0	124.9
39	Miscellaneous manufacturing industries (12/85 = 100)	129.7	130.3	130.1	130.0
	Service industries:				
42	Motor freight transportation and warehousing (06/93= 100)	111.6	114.8	115.1	115.8
43	U.S. Postal Service (06/89 = 100)	132.3	135.3	135.2	135.2
44	Water transportation (12/92= 100)	105.6	113.0	117.2	117.3
45	Transportation by air (12/92 = 100)	124.5	130.8	131.7	131.8
46	Pipelinest except natural gas				

SIC	Industry	1999 Oct.	1999 Nov.	1999 Dec.	2000 Jan.
	(12/92 = 100)	99.2	98.3	98.2	98.3
--	Total mining Industries	87.7	95.1	86.7	89.5
10	Metal mining	76.3	73.4	72.6	73.9
12	Coal mining (12/85 = 100)	86.0	86.1	85.4	85.3
13	Oil and gas extraction (12/85 = 100)	91.2	101.6	90.4	94.2
14	Mining and quarrying of nonmetallic minerals, except fuels	134.4	134.4	134.4	135.0
--	Total manufacturing Industries	130.2	130.3	130.5	130.8
20	Food and kindred products	127.5	127.1	126.7	126.7
21	Tobacco manufactures	344.4	344.5	345.0	329.4
22	Textile mill products	116.1	115.9	116.1	116.2
23	Apparel and other finished products made from fabrics and similar materials	125.6	125.4	125.3	125.2
24	Lumber and wood products, except furniture	160.0	159.6	160.6	161.4
25	Furniture and fixtures	142.0	142.0	142.1	42.4
26	Paper and allied products	139.9	140.2	140.4	141.0
27	Printing, publishing, and allied industries	178.6	179.1	179.2	180.4
28	Chemicals and allied products	152.8	153.0	152.9	153.6
29	Petroleum refining and related products	87.0	89.5	91.8	94.0
30	Rubber and miscellaneous plastics products	122.9	123.3	123.4	123.5
31	Leather and leather products	137.0	137.0	137.0	137.5
32	Stone, clay, glass, and concrete products	133.6	133.7	133.5	134.4
33	Primary metal industries	117.1	117.1	117.4	118.6
34	Fabricated metal products, except machinery and transportation equipment	129.4	129.6	129.7	129.9
35	Machinery, except electrical	117.1	117.1	117.0	117.1
36	Electrical and electronic machinery, equipment, and supplies	109.1	109.1	108.9	108.7
37	Transportation	136.7	136.2	136.2	136.3
38	Measuring and controlling				

	instruments; photo- graphic, medical, and optical goods; watches and clocks	125.2	125.3	125.6	126.0
39	Miscellaneous manufacturing industries (12/85 = 100)	130.4	130.2	130.5	130.7
	Service industries:				
42	Motor freight transportation and warehousing (06/93= 100)	115.5	115.8	115.8	116.5
43	U.S. Postal Service (06/89 = 100)	135.2	135.2	135.2	135.2
44	Water transportation (12/92= 100)	116.7	116.1	116.1	116.4
45	Transportation by air (12/92 = 100)	133.1	134.2	134.2	141.0
46	Pipelinest except natural gas (12/92 = 100)	98.3	98.2	98.2	102.1

		2000			
SIC	Industry	Feb.	Mar.	Apr.	May
--	Total mining Industries	95.8	98.9	95.7	100.0
10	Metal mining	75.3	73.3	71.8	71.7
12	Coal mining (12/85 = 100)	84.7	84.8	85.9	86.0
13	Oil and gas extraction (12/85 = 100)	102.6	107.0	102.7	108.3
14	Mining and quarrying of nonmetallic minerals, except fuels	135.3	135.7	136.7	137.5
--	Total manufacturing Industries	132.2	132.9	132.6	133.4
20	Food and kindred products	127.2	127.4	128.1	129.1
21	Tobacco manufactures	348.6	347.3	341.8	347.1
22	Textile mill products	116.4	116.5	116.5	116.3
23	Apparel and other finished products made from fabrics and similar materials	125.2	125.6	125.7	125.6
24	Lumber and wood products, except furniture	161.6	162.1	161.7	159.0
25	Furniture and fixtures	142.5	143.0	143.2	143.3
26	Paper and allied products	141.5	143.2	145.4	146.9
27	Printing, publishing, and allied industries	180.8	181.1	182.0	181.7
28	Chemicals and allied products	154.5	155.2	155.5	156.9
29	Petroleum refining and related products	104.1	111.0	105.6	111.4

30	Rubber and miscellaneous plastics products	123.5	123.5	123.7	123.3
31	Leather and leather products	137.5	137.4	137.6	137.5
32	Stone, clay, glass, and concrete products	134.6	134.7	135.0	134.8
33	Primary metal industries	119.5	120.0	120.3	120.5
34	Fabricated metal products, except machinery and transportation equipment	130.0	130.3	130.4	130.3
35	Machinery, except electrical	117.3	117.4	117.4	117.5
36	Electrical and electronic machinery, equipment, and supplies	108.6	108.6	108.6	108.6
37	Transportation	136.5	136.4	136.4	136.1
38	Measuring and controlling instruments; photo-graphic, medical, and optical goods; watches and clocks	126.2	126.0	126.0	126.3
39	Miscellaneous manufacturing industries (12/85 = 100)	131.1	130.8	130.8	131.3
	Service industries:				
42	Motor freight transportation and warehousing (06/93= 100)	117.0	118.1	118.1	118.8
43	U.S. Postal Service (06/89 = 100)	135.2	135.2	135.2	135.2
44	Water transportation (12/92= 100)	117.0	117.8	117.8	119.8
45	Transportation by air (12/92 = 100)	141.6	144.3	144.3	149.6
46	Pipelinest except natural gas (12/92 = 100)	101.9	101.9	101.9	101.9

		2000		
SIC	Industry	June	July	Aug.
--	Total mining Industries	113.8	114.8	115.4
10	Metal mining	73.7	72.8	72.8
12	Coal mining (12/85 = 100)	85.0	85.4	83.5
13	Oil and gas extraction (12/85 = 100)	127.1	128.3	129.6
14	Mining and quarrying of nonmetallic minerals, except fuels	136.8	138.4	137.9

--	Total manufacturing Industries	134.0	133.6	133.4
20	Food and kindred products	129.1	129.3	128.2
21	Tobacco manufactures	342.2	342.3	350.5
22	Textile mill products	116.2	116.8	116.8
23	Apparel and other finished products made from fabrics and similar materials	125.5	125.8	125.6
24	Lumber and wood products, except furniture	158.4	157.2	155.8
25	Furniture and fixtures	143.5	143.7	143.6
26	Paper and allied products	147.2	147.3	147.3
27	Printing, publishing, and allied industries	182.9	183.0	183.1
28	Chemicals and allied products	157.1	158.0	157.5
29	Petroleum refining and related products	118.0	112.6	112.8
30	Rubber and miscellaneous plastics products	123.9	124.8	125.0
31	Leather and leather products	137.4	137.5	138.0
32	Stone, clay, glass, and concrete products	134.9	134.9	134.6
33	Primary metal industries	120.1	119.9	120.1
34	Fabricated metal products, except machinery and transportation equipment	130.3	130.3	130.4
35	Machinery, except electrical	117.5	117.6	117.5
36	Electrical and electronic machinery, equipment, and supplies	108.6	108.6	108.1
37	Transportation	136.0	136.0	135.6
38	Measuring and controlling instruments; photo-graphic, medical, and optical goods; watches and clocks	126.5	126.5	126.6
39	Miscellaneous manufacturing industries (12/85 = 100)	131.3	131.0	131.1
	Service industries:			
42	Motor freight transportation and warehousing (06/93= 100)	119.4	118.8	120.1
43	U.S. Postal Service			

(06/89 = 100)	135.2	135.2	135.2
44 Water transportation			
(12/92= 100)	123.2	124.8	128.1
45 Transportation by air			
(12/92 = 100)	147.5	147.6	148.3
46 Pipelinest except natural gas			
(12/92 = 100)	102.0	102.5	102.5

33. Annual data: Producer Price Indexes, by stage of processing (1982 = 100)

Index	1991	1992	1993	1994
Finished goods				
Total	121.7	123.2	124.7	125.5
Foods	124.1	123.3	125.7	126.8
Energy	78.1	77.8	78.0	77.0
Other	131.1	134.2	135.8	137.1
Intermediate materials, supplies, and components				
Total	114.4	114.7	116.2	118.5
Foods	115.3	113.9	115.6	118.5
Energy	85.1	84.3	84.6	83.0
Other	121.4	122.0	123.8	127.1
Crude materials for further processing				
Total	101.2	100.4	102.4	101.8
Foods	105.5	105.1	108.4	106.5
Energy	80.4	78.8	76.7	72.1
Other	97.5	94.2	94.1	97.0

Index	1995	1996	1997	1998
Finished goods				
Total	127.9	131.3	131.8	130.7
Foods	129.0	133.6	134.5	134.3
Energy	78.1	83.2	83.4	75.1
Other	140.0	142.0	142.4	143.7
Intermediate materials, supplies, and components				
Total	124.9	125.7	125.6	123.0
Foods	119.5	125.3	123.2	123.2
Energy	84.1	89.8	89.0	80.8
Other	135.2	134.0	134.2	133.5
Crude materials for further processing				
Total	102.7	113.8	111.1	96.8
Foods	105.8	121.5	112.2	103.9
Energy	69.4	85.0	87.3	68.6
Other	105.8	105.7	103.5	84.5

Index	1999
Finished goods	
Total	133.0
Foods	135.1
Energy	78.8

Other	146.1
Intermediate materials, supplies, and components	
Total	123.2
Foods	120.8
Energy	84.3
Other	133.1
Crude materials for further processing	
Total	98.2
Foods	98.7
Energy	78.5
Other	91.1

34. U.S. export price indexes by Standard International Trade Classification

(1995 = 100, unless otherwise indicated)

SITC Rev. 3	Industry	1999 Aug.	Sept.	Oct.	Nov.
0	Food and live animals	87.6	86.6	86.4	86.3
1	Meat and meat preparations	97.3	97.5	97.4	97.7
4	Cereals and cereal preparations	73.3	72.7	89.5	70.1
5	Vegetables, fruit, and nuts, prepared fresh or dry	97.8	94.3	96.6	94.3
2	Crude materials, inedible, except fuels	76.5	77.7	78.1	77.8
21	Hides, skins, and furskins, raw	83.4	86.5	88.6	87.8
22	Oilseeds and oleaginous fruits	80.1	85.0	32.3	78.1
24	Cork and wood	83.0	82.8	83.5	83.8
25	Pulp and waste paper	73.5	75.2	77.1	78.7
26	Textile fibers and their waste	65.1	64.4	64.5	63.4
27	Crude fertilizers and crude minerals	93.0	93.3	93.1	93.8
28	Metalliferous ores and metal scrap	73.0	73.5	75.1	77.3
3	Mineral fuels, lubricants, and related products	113.8	115.3	119.5	121.4
32	Coal, coke, and briquettes	98.3	97.6	97.6	97.6
33	Petroleum, petroleum products, and related materials	126.4	128.6	131.3	133.4
4	Animal and vegetable oils, fats, and waxes	77.1	78.8	81.9	79.0
5	Chemicals and related products, n.e.s.	91.8	92.3	93.3	93.3

SITC Rev. 3	Industry	1999 Dec.	2000 Jan.	Feb.	Mar.
54	Medicinal and pharmaceutical products	99.9	99.8	99.8	99.8
55	Essential oils; polishing and cleaning preparations	101.8	102.1	102.3	103.5
57	Plastics in primary forms (12/92 = 100)	90.6	92.1	94.4	97.8
56	Plastics in nonprimary forms (12/92 = 100)	97.4	97.6	97.9	97.8
59	Chemical materials and products, n.e.s.	99.3	99.2	98.9	98.8
6	Manufactured goods classified chiefly by materials	97.3	97.5	97.8	98.0
62	Rubber manufactures, n.e.s.	105.8	106.9	108.2	108.2
64	Paper, paperboard, and articles of paper, pulp, and paperboard	85.4	86.3	87.2	87.6
66	Nonmetallic mineral manufactures, n.e.s.	106.3	106.1	106.0	106.0
68	Nonferrous metals	87.0	88.0	90.2	90.7
7	Machinery and transport equipment	97.3	97.2	97.4	97.5
71	Power generating machinery and equipment	110.1	110.1	110.2	111.0
72	Machinery specialized for particular industries	105.8	105.9	106.0	106.1
74	General industrial machines and parts, n.e.s., and machine parts recording	107.5	107.6	107.7	107.7
75	Computer equipment and office machines	71.0	70.2	70.5	70.4
76	Telecommunications and sound and reproducing apparatus and equipment	96.9	96.9	96.6	96.6
77	Electrical machinery and equipment	87.5	87.6	87.4	87.3
78	Road vehicles	102.3	102.4	103.1	103.1
87	Professional, scientific, and controlling Instruments and apparatus	105.4	105.4	105.5	105.6

0	Food and live animals	85.6	86.3	86.9	86.8
1	Meat and meat preparations	100.9	100.1	98.0	99.4
4	Cereals and cereal preparations	68.5	71.0	74.1	74.4
5	Vegetables, fruit, and nuts, prepared fresh or dry	91.2	90.9	89.0	88.6
2	Crude materials, inedible, except fuels	78.9	80.0	82.2	83.2
21	Hides, skins, and furskins, raw	90.5	91.1	89.5	87.7
22	Oilseeds and oleaginous fruits	79.6	80.5	84.8	86.0
24	Cork and wood	85.0	86.4	86.5	87.2
25	Pulp and waste paper	80.9	84.3	88.3	90.0
26	Textile fibers and their waste	62.5	61.2	65.7	68.6
27	Crude fertilizers and crude minerals	94.1	94.3	94.0	93.5
28	Metalliferous ores and metal scrap	78.4	80.0	80.7	80.9
3	Mineral fuels, lubricants, and related products	126.6	129.5	138.5	152.1
32	Coal, coke, and briquettes	97.5	96.1	96.1	96.1
33	Petroleum, petroleum products, and related materials	140.1	143.6	159.6	179.2
4	Animal and vegetable oils, fats, and waxes	78.0	75.8	74.3	70.8
5	Chemicals and related products, n.e.s.	93.6	93.8	94.2	94.4
54	Medicinal and pharmaceutical products	100.3	100.2	100.4	100.2
55	Essential oils; polishing and cleaning preparations	103.4	103.4	103.3	103.0
57	Plastics in primary forms (12/92 = 100)	95	94.8	94.8	95.5
56	Plastics in nonprimary forms (12/92 = 100)	98.0	97.8	98.6	100.1
59	Chemical materials and products, n.e.s.	99.1	99.2	99.9	99.6
6	Manufactured goods classified chiefly by materials	98.3	98.3	99.0	99.7
62	Rubber manufactures, n.e.s.	108.5	104.7	103.7	103.6
64	Paper, paperboard, and articles of				

	paper, pulp, and paperboard	87.2	87.6	87.8	88.4
66	Nonmetallic mineral manufactures, n.e.s.	105.8	105.8	106.0	106.2
68	Nonferrous metals	92.3	93.4	98.8	101.9
7	Machinery and transport equipment	97.2	97.4	97.3	97.3
71	Power generating machinery and equipment	111.0	111.8	111.8	111.8
72	Machinery specialized for particular industries	104.7	106.2	106.3	106.1
74	General industrial machines and parts, n.e.s., and machine parts recording	107.9	107.5	107.6	108.0
75	Computer equipment and office machines	70.2	70.1	68.7	68.7
76	Telecommunications and sound and reproducing apparatus and equipment	96.7	96.4	97.0	96.6
77	Electrical machinery and equipment	86.7	86.4	86.6	86.3
78	Road vehicles	103.1	103.5	103.6	104.0
87	Professional, scientific, and controlling Instruments and apparatus	105.3	105.2	105.4	105.7

SITC Rev. 3	Industry	2000 Apr.	May	June	July
0	Food and live animals	87.5	88.3	87.5	85.8
1	Meat and meat preparations	102.2	105.1	109.5	108.4
4	Cereals and cereal preparations	74.0	75.0	71.6	66.8
5	Vegetables, fruit, and nuts, prepared fresh or dry	90.6	90.1	87.8	91.2
2	Crude materials, inedible, except fuels	84.2	85.2	84.4	82.9
21	Hides, skins, and furskins, raw	85.5	86.5	86.7	89.7
22	Oilseeds and oleaginous fruits	88.3	89.1	86.3	80.3
24	Cork and wood	87.4	86.7	86.7	86.5
25	Pulp and waste paper	93.8	99.0	97.6	95.9
26	Textile fibers and their waste	68.9	69.0	69.6	67.7
27	Crude fertilizers and				

	crude minerals	93.0	93.0	93.3	93.3
28	Metalliferous ores and metal scrap	80.4	79.6	78.2	78.0
3	Mineral fuels, lubricants, and related products	137.2	142.3	144.9	151.3
32	Coal, coke, and briquettes	94.7	94.5	93.8	93.8
33	Petroleum, petroleum products, and related materials	152.0	163.1	168.2	178.4
4	Animal and vegetable oils, fats, and waxes	71.6	70.1	67.1	64.6
5	Chemicals and related products, n.e.s.	95.8	95.8	95.5	95.3
54	Medicinal and pharmaceutical products	99.9	100.0	99.7	100.4
55	Essential oils; polishing and cleaning preparations	103.2	103.1	102.9	103.0
57	Plastics in primary forms (12/92 = 100)	97.7	98.4	97.0	97.0
56	Plastics in nonprimary forms (12/92 = 100)	100.2	99.8	99.3	99.4
59	Chemical materials and products, n.e.s.	99.4	99.3	99.1	99.3
6	Manufactured goods classified chiefly by materials	99.9	100.1	100.4	100.6
62	Rubber manufactures, n.e.s.	103.7	104.6	104.4	104.8
64	Paper, paperboard, and articles of paper, pulp, and paperboard	89.1	90.5	89.8	90.2
66	Nonmetallic mineral manufactures, n.e.s.	106.4	106.4	106.5	106.3
68	Nonferrous metals	100.3	98.1	100.1	102.3
7	Machinery and transport equipment	97.3	97.4	97.3	97.3
71	Power generating machinery and equipment	111.9	112.0	112.0	112.2
72	Machinery specialized for particular industries	106.2	106.5	106.5	106.5
74	General industrial machines and parts, n.e.s., and machine parts recording	108.2	108.2	108.3	108.3
75	Computer equipment and office machines	68.5	68.5	68.2	68.1

76	Telecommunications and sound and reproducing apparatus and equipment	96.4	97.0	96.9	96.7
77	Electrical machinery and equipment	86.4	86.3	85.7	85.6
78	Road vehicles	103.9	103.9	103.9	103.9
87	Professional, scientific, and controlling Instruments and apparatus	105.7	105.7	105.8	106.4

SITC Rev. 3	Industry	2000 Aug.
0	Food and live animals	83.2
1	Meat and meat preparations	104.1
4	Cereals and cereal preparations	64.0
5	Vegetables, fruit, and nuts, prepared fresh or dry	88.5
2	Crude materials, inedible, except fuels	82.5
21	Hides, skins, and furskins, raw	95.4
22	Oilseeds and oleaginous fruits	78.0
24	Cork and wood	87.7
25	Pulp and waste paper	90.7
26	Textile fibers and their waste	70.1
27	Crude fertilizers and crude minerals	93.1
28	Metalliferous ores and metal scrap	78.8
3	Mineral fuels, lubricants, and related products	147.7
32	Coal, coke, and briquettes	93.1
33	Petroleum, petroleum products, and related materials	172.5
4	Animal and vegetable oils, fats, and waxes	63.2
5	Chemicals and related products, n.e.s.	94.6
54	Medicinal and pharmaceutical products	100.3
55	Essential oils;	

	polishing and cleaning preparations	103.0
57	Plastics in primary forms (12/92 = 100)	95.4
56	Plastics in nonprimary forms (12/92 = 100)	99.4
59	Chemical materials and products, n.e.s.	99.2
6	Manufactured goods classified chiefly by materials	101.0
62	Rubber manufactures, n.e.s.	104.7
64	Paper, paperboard, and articles of paper, pulp, and paperboard	90.3
66	Nonmetallic mineral manufactures, n.e.s.	106.3
68	Nonferrous metals	105.6
7	Machinery and transport equipment	97.3
71	Power generating machinery and equipment	112.2
72	Machinery specialized for particular industries	106.4
74	General industrial machines and parts, n.e.s., and machine parts recording	108.3
75	Computer equipment and office machines	67.6
76	Telecommunications and sound and reproducing apparatus and equipment	96.6
77	Electrical machinery and equipment	85.7
78	Road vehicles	103.9
87	Professional, scientific, and controlling Instruments and apparatus	106.4

35. U.S. import price indexes by Standard International Trade Classification

(1995 = 100, unless otherwise indicated)

SITC Rev. 3	Industry	1999 Aug.	Sept.	Oct.
0	Food and live animals	92.0	91.5	91.0

01	Meat and meat preparations	96.7	99.4	98.4
03	Fish and crustaceans, mollusks, and other aquatic invertebrates	103.8	103.1	105.0
05	Vegetables, fruit, and nuts, prepared fresh or dry	102.6	101.6	96.5
07	Coffee, tea, cocoa, spices, and manufactures thereof	63.2	61.4	62.0
1	Beverages and tobacco	111.2	112.2	111.5
11	Beverages	107.7	109.1	108.5
2	Crude materials, inedible, except fuels	92.7	91.7	90.8
24	Cork and wood	128.9	121.7	1167.0
25	Pulp and waste paper	61.1	66.0	63.9
28	Metalliferous ores and metal scrap	93.8	94.3	98.4
29	Crude animal and vegetable materials, n.e.s.	105.0	111.1	112.1
3	Mineral fuels, lubricants, and related products	117.1	126.5	128.0
33	Petroleum, petroleum products, and related materials	115.9	125.7	127.4
34	Gas, natural and manufactured	134.1	142.2	1411.0
5	Chemicals and related products, n.e.s.	90.4	91.3	91.8
52	Inorganic chemicals	86.2	86.6	87.2
53	Dying, tanning, and coloring materials	90.5	90.2	90.6
54	Medicinal and pharmaceutical products	96.3	97.0	97.4
55	Essential oils; polishing and cleaning preparations	91.8	92.3	91.8
57	Plastics in primary forms (12/92 = 100)	93.1	93.8	93.8
58	Plastics in nonprimary forms (12/92 = 100)	76.1	77.9	78.9
59	Chemical materials and products, n.e.s.	98.1	98.1	98.6
6	Manufactured goods classified chiefly by materials	92.4	92.6	93.3
62	Rubber manufactures, n.e.s.	94.5	95.0	94.9
64	Paper, paperboard, and articles of paper, pulp, and paperboard	83.5	83.7	84.4
66	Nonmetallic mineral manufactures, n.e.s.	100.9	101.1	101.2
68	Nonferrous metals	89.9	91.1	94.8
69	Manufactures of metals, n.e.s.	95.6	95.8	95.6
7	Machinery and transport equipment	89.9	89.9	89.9
72	Machinery specialized for particular industries	97.2	97.6	97.8
74	General industrial machines			

	and parts, n.e.s., and machine parts	97.3	97.4	97.3
75	Computer equipment and office machines	61.8	61.6	61.4
76	Telecommunications and sound recording and reproducing apparatus and equipment	87.0	87.1	86.0
77	Electrical machinery and equipment	82.1	82.5	82.6
78	Road vehicles	102.4	102.2	102.4
85	Footwear	100.6	100.8	100.8
88	Photographic apparatus, equipment, and supplies, and optical goods, n.e.s.	91.1	91.4	92.2

SITC Rev. 3	Industry	1999 Nov.	1999 Dec.	2000 Jan.
0	Food and live animals	92.4	94.7	93.7
01	Meat and meat preparations	97.7	98.4	97.8
03	Fish and crustaceans, mollusks, and other aquatic invertebrates	107.5	106.8	106.8
05	Vegetables, fruit, and nuts, prepared fresh or dry	97.2	103.6	102.0
07	Coffee, tea, cocoa, spices, and manufactures thereof	66.0	70.6	67.2
1	Beverages and tobacco	111.5	112.0	111.2
11	Beverages	108.5	108.7	107.9
2	Crude materials, inedible, except fuels	90.3	92.2	93.6
24	Cork and wood	114.9	116.7	117.7
25	Pulp and waste paper	66.8	68.2	70.5
28	Metalliferous ores and metal scrap	98.0	99.0	101.4
29	Crude animal and vegetable materials, n.e.s.	106.5	111.9	121.1
3	Mineral fuels, lubricants, and related products	134.7	141.2	145.2
33	Petroleum, petroleum products, and related materials	132.6	141.4	146.1
34	Gas, natural and manufactured	161.5	150.2	147.8
5	Chemicals and related products, n.e.s.	92.1	92.0	92.2
52	Inorganic chemicals	87.7	88.0	88.3
53	Dying, tanning, and coloring materials	91.4	89.7	88.9
54	Medicinal and pharmaceutical products	97.8	97.3	98.2
55	Essential oils; polishing and cleaning preparations	92.3	90.2	89.6
57	Plastics in primary forms (12/92 = 100)	93.9	94.0	93.7

58	Plastics in nonprimary forms (12/92 = 100)	79.4	79.7	79.3
59	Chemical materials and products, n.e.s.	98.4	99.5	100.0
6	Manufactured goods classified chiefly by materials	93.9	93.9	94.5
62	Rubber manufactures, n.e.s.	94.4	94.4	92.7
64	Paper, paperboard, and articles of paper, pulp, and paperboard	87.4	86.2	86.6
66	Nonmetallic mineral manufactures, n.e.s.	101.6	101.2	100.8
68	Nonferrous metals	95.4	95.6	98.9
69	Manufactures of metals, n.e.s.	95.9	959.0	95.7
7	Machinery and transport equipment	89.8	89.7	89.8
72	Machinery specialized for particular industries	98.2	97.8	97.7
74	General industrial machines and parts, n.e.s., and machine parts	97.3	97.0	97.0
75	Computer equipment and office machines	61.4	61.7	61.5
76	Telecommunications and sound recording and reproducing apparatus and equipment	85.9	85.6	85.2
77	Electrical machinery and equipment	82.2	82.1	82.4
78	Road vehicles	102.4	102.3	102.4
85	Footwear	100.8	100.8	100.8
88	Photographic apparatus, equipment, and supplies, and optical goods, n.e.s.	92.5	92.5	92.2

SITC Rev. 3	Industry	2000 Feb.	Mar.	Apr.
0	Food and live animals	93.6	93.1	94.0
01	Meat and meat preparations	98.2	99.1	100.2
03	Fish and crustaceans, mollusks, and other aquatic invertebrates	107.9	108.0	111.0
05	Vegetables, fruit, and nuts, prepared fresh or dry	102.1	101.2	100.7
07	Coffee, tea, cocoa, spices, and manufactures thereof	64.7	61.0	61.1
1	Beverages and tobacco	111.4	111.7	111.9
11	Beverages	108.2	108.5	108.7
2	Crude materials, inedible, except fuels	94.7	94.3	93.8
24	Cork and wood	117.0	118.6	117.6
25	Pulp and waste paper	72.0	72.4	75.1
28	Metalliferous ores and			

	metal scrap	105.7	104.0	101.7
29	Crude animal and vegetable materials, n.e.s.	124.3	111.9	110.1
3	Mineral fuels, lubricants, and related products	165.7	165.4	148.5
33	Petroleum, petroleum products, and related materials	167.9	166.6	147.1
34	Gas, natural and manufactured	161.4	170.5	171.5
5	Chemicals and related products, n.e.s.	92.7	92.8	93.4
52	Inorganic chemicals	89.0	88.8	89.8
53	Dying, tanning, and coloring materials	89.3	88.4	88.0
54	Medicinal and pharmaceutical products	98.2	97.3	97.3
55	Essential oils; polishing and cleaning preparations	89.6	89.7	89.4
57	Plastics in primary forms (12/92 = 100)	93.0	93.9	93.9
58	Plastics in nonprimary forms (12/92 = 100)	79.0	80.4	80.3
59	Chemical materials and products, n.e.s.	101.6	100.6	100.0
6	Manufactured goods classified chiefly by materials	95.5	98.0	97.5
62	Rubber manufactures, n.e.s.	92.8	92.3	92.4
64	Paper, paperboard, and articles of paper, pulp, and paperboard	86.9	87.1	88.8
66	Nonmetallic mineral manufactures, n.e.s.	101.2	100.8	100.9
68	Nonferrous metals	104.4	115.1	110.3
69	Manufactures of metals, n.e.s.	96.1	96.1	95.9
7	Machinery and transport equipment	89.8	89.6	89.7
72	Machinery specialized for particular industries	97.9	97.3	97.1
74	General industrial machines and parts, n.e.s., and machine parts	96.7	97.0	96.9
75	Computer equipment and office machines	61.4	61.0	80.5
76	Telecommunications and sound recording and reproducing apparatus and equipment	85.2	64.9	64.5
77	Electrical machinery and equipment	82.2	82.2	83.0
78	Road vehicles	102.6	102.8	102.7
85	Footwear	100.9	100.7	100.5
88	Photographic apparatus, equipment, and supplies, and optical goods, n.e.s.	91.7	91.8	91.8

2000

SITC Rev. 3	Industry	May	June	July
0	Food and live animals	92.3	91.3	91.4
01	Meat and meat preparations	100.2	99.1	98.1
03	Fish and crustaceans, mollusks, and other aquatic invertebrates	109.6	109.1	110.5
05	Vegetables, fruit, and nuts, prepared fresh or dry	96.8	95.7	97.2
07	Coffee, tea, cocoa, spices, and manufactures thereof	59.8	59.5	56.8
1	Beverages and tobacco	112.4	113.0	112.5
11	Beverages	109.4	110.1	109.4
2	Crude materials, inedible, except fuels	91.9	90.7	90.7
24	Cork and wood	112.9	110.1	107.0
25	Pulp and waste paper	77.0	80.1	80.7
28	Metalliferous ores and metal scrap	99.6	100.7	101.3
29	Crude animal and vegetable materials, n.e.s.	106.7	92.7	101.8
3	Mineral fuels, lubricants, and related products	154.3	172.0	170.4
33	Petroleum, petroleum products, and related materials	154.2	171.0	168.2
34	Gas, natural and manufactured	167.5	195.4	203.1
5	Chemicals and related products, n.e.s.	94.3	94.1	95.5
52	Inorganic chemicals	90.7	91.5	92.5
53	Dying, tanning, and coloring materials	87.4	86.1	87.6
54	Medicinal and pharmaceutical products	97.3	96.8	97.5
55	Essential oils; polishing and cleaning preparations	69.9	89.6	89.9
57	Plastics in primary forms (12/92 = 100)	94.0	94.3	95.5
58	Plastics in nonprimary forms (12/92 = 100)	80.8	80.8	81.5
59	Chemical materials and products, n.e.s.	100.9	99.7	100.2
6	Manufactured goods classified chiefly by materials	97.1	97.6	98.0
62	Rubber manufactures, n.e.s.	92.5	91.8	92.1
64	Paper, paperboard, and articles of paper, pulp, and paperboard	89.6	89.1	89.5
66	Nonmetallic mineral manufactures, n.e.s.	100.7	100.5	100.9
68	Nonferrous metals	106.9	110.7	112.5
69	Manufactures of metals, n.e.s.	95.9	95.7	95.8

7	Machinery and transport equipment	89.8	89.6	89.6
72	Machinery specialized for particular industries	97.0	96.1	96.7
74	General industrial machines and parts, n.e.s., and machine parts	98.7	98.2	96.7
75	Computer equipment and office machines	60.2	60.0	59.9
76	Telecommunications and sound recording and reproducing apparatus and equipment	64.7	64.6	64.2
77	Electrical machinery and equipment	83.5	83.3	82.9
78	Road vehicles	102.7	102.8	102.8
85	Footwear	100.7	100.3	100.9
88	Photographic apparatus, equipment, and supplies, and optical goods, n.e.s.	91.9	91.6	92.5

SITC Rev. 3	Industry	2000 Aug.
0	Food and live animals	91.6
01	Meat and meat preparations	98.9
03	Fish and crustaceans, mollusks, and other aquatic invertebrates	113.1
05	Vegetables, fruit, and nuts, prepared fresh or dry	97.5
07	Coffee, tea, cocoa, spices, and manufactures thereof	55.8
1	Beverages and tobacco	114.5
11	Beverages	111.7
2	Crude materials, inedible, except fuels	89.6
24	Cork and wood	102.1
25	Pulp and waste paper	81.4
28	Metalliferous ores and metal scrap	102.2
29	Crude animal and vegetable materials, n.e.s.	101.3
3	Mineral fuels, lubricants, and related products	171.2
33	Petroleum, petroleum products, and related materials	168.1
34	Gas, natural and manufactured	212.1
5	Chemicals and related products, n.e.s.	95.5
52	Inorganic chemicals	92.6
53	Dying, tanning, and coloring materials	89.1
54	Medicinal and pharmaceutical	

	products	97.3
55	Essential oils; polishing and cleaning preparations	89.3
57	Plastics in primary forms (12/92 = 100)	95.4
58	Plastics in nonprimary forms (12/92 = 100)	80.9
59	Chemical materials and products, n.e.s.	100.3
6	Manufactured goods classified chiefly by materials	98.8
62	Rubber manufactures, n.e.s.	91.9
64	Paper, paperboard, and articles of paper, pulp, and paperboard	89.4
66	Nonmetallic mineral manufactures, n.e.s.	101.0
68	Nonferrous metals	118.6
69	Manufactures of metals, n.e.s.	95.7
7	Machinery and transport equipment	89.5
72	Machinery specialized for particular industries	96.6
74	General industrial machines and parts, n.e.s., and machine parts	96.4
75	Computer equipment and office machines	59.9
76	Telecommunications and sound recording and reproducing apparatus and equipment	64.2
77	Electrical machinery and equipment	62.8
78	Road vehicles	102.7
85	Footwear	101.0
88	Photographic apparatus, equipment, and supplies, and optical goods, n.e.s.	92.1

36. U.S. export price indexes by end-use category (1995 = 100)

Category	Aug. 1999	Sept. 1999	Oct. 1999	Nov. 1999
ALL COMMODITIES	94.7	94.8	95.1	95.3
Foods, feeds, and beverages	87.9	87.6	87.4	85.7
Agricultural foods, feeds, and beverages	86.9	86.7	86.4	85.6
Nonagricultural (fish, beverages) food products	99.5	98.2	99.7	99.2
Industrial supplies and materials	89.0	89.5	90.4	91.1
Agricultural industrial supplies and materials	76.3	76.6	77.5	76.6

Fuels and lubricants	110.5	111.8	114.4	115.9
Nonagricultural supplies and materials, excluding fuel and building materials	87.0	87.5	88.3	89.1
Selected building materials	88.4	87.4	87.8	87.7
Capital goods	96.2	96.1	96.2	96.3
Electric and electrical generating equipment	98.0	98.3	98.3	98.4
Nonelectrical machinery	926.0	92.4	92.4	92.5
Automotive vehicles, parts, and engines	103.2	103.3	104.0	103.9
Consumer goods, excluding automotive	102.0	101.9	102.2	102.2
Nondurables, manufactured	102.0	102.1	102.4	102.5
Durables, manufactured	100.8	100.7	100.8	100.9
Agricultural commodities	84.7	84.6	84.5	83.7
Nonagricultural commodities	95.8	95.9	96.3	96.6

		1999		
Category	Dec.	Jan.	Feb.	Mar.
ALL COMMODITIES	95.2	95.4	95.8	96.3
Foods, feeds, and beverages	86.0	86.3	87.2	87.1
Agricultural foods, feeds, and beverages	84.9	85.4	86.0	86.2
Nonagricultural (fish, beverages) food products	99.5	98.3	100.9	97.8
Industrial supplies and materials	91.7	92.1	93.6	95.2
Agricultural industrial supplies and materials	76.7	75.2	76.9	77.7
Fuels and lubricants	120.4	22.7	131.3	143.6
Nonagricultural supplies and materials, excluding fuel and building materials	89.3	89.7	90.4	91.0
Selected building materials	88.6	89.2	89.5	90.1
Capital goods	96.0	96.1	96.0	96.0
Electric and electrical generating equipment	98.5	98.3	98.8	98.8
Nonelectrical machinery	92.1	92.1	91.9	91.8
Automotive vehicles, parts, and engines	103.9	103.8	103.8	104.2
Consumer goods, excluding automotive	102.4	102.4	102.5	102.3
Nondurables, manufactured	102.9	102.8	102.8	102.4

Durables, manufactured	100.8	101.0	101.0	101.0
Agricultural commodities	83.1	83.2	83.2	84.4
Nonagricultural commodities	96.6	96.8	96.8	97.2

Category	2000 Apr.	May	June	July
ALL COMMODITIES	96.2	96.4	96.3	96.3
Foods, feeds, and beverages	87.8	88.3	87.1	85.1
Agricultural foods, feeds, and beverages	87.1	87.7	86.2	84.0
Nonagricultural (fish, beverages) food products	97.0	96.6	98.1	97.9
Industrial supplies and materials	94.6	95.2	95.2	95.6
Agricultural industrial supplies and materials	78.2	78.2	78.2	77.9
Fuels and lubricants	127.8	132.9	135.6	141.2
Nonagricultural supplies and materials, excluding fuel and building materials	91.9	92.1	91.9	91.9
Selected building materials	90.4	90.0	89.9	89.6
Capital goods	96.1	96.1	96.1	96.1
Electric and electrical generating equipment	98.7	98.9	99.2	99.0
Nonelectrical machinery	91.9	91.9	91.7	91.6
Automotive vehicles, parts, and engines	104.2	104.2	104.1	104.4
Consumer goods, excluding automotive	102.4	102.4	102.3	102.4
Nondurables, manufactured	102.3	102.4	102.1	102.3
Durables, manufactured	101.3	101.3	101.3	101.5
Agricultural commodities	85.1	85.6	84.4	82.6
Nonagricultural commodities	97.6	97.7	97.6	97.8

Category	2000 Aug.
ALL COMMODITIES	96.0
Foods, feeds, and beverages	82.8
Agricultural foods, feeds, and beverages	81.3
Nonagricultural (fish, beverages) food products	99.7
Industrial supplies and materials	95.4

Agricultural industrial supplies and materials	80.3
Fuels and lubricants	137.9
Nonagricultural supplies and materials, excluding fuel and building materials	91.6
Selected building materials	90.5
Capital goods	96.1
Electric and electrical generating equipment	99.5
Nonelectrical machinery	91.6
Automotive vehicles, parts, and engines	104.4
Consumer goods, excluding automotive	102.4
Nondurables, manufactured	102.3
Durables, manufactured	101.4
Agricultural commodities	80.9
Nonagricultural commodities	97.7

37. U.S. import price indexes by end-use category
(1995 = 100)

Category	1999 Aug.	Sept.	Oct.
ALL COMMODITIES	94.3	95.2	95.4
Foods, feeds, and beverages	92.5	92.3	91.6
Agricultural foods, feeds, and beverages	87.7	87.6	86.1
Nonagricultural (fish, beverages) food products	105.0	104.9	106.3
Industrial supplies and materials	99.9	103.1	104.3
Fuels and lubricants	116.7	126.0	128.1
Petroleum and petroleum products	115.6	125.2	127.3
Paper and paper base stocks	76.9	78.4	78.5
Materials associated with nondurable supplies and materials	86.9	87.7	88.3
Selected building materials	118.9	113.4	110.0
Unfinished metals associated with durable goods	89.0	89.7	93.0
Nonmetals associated with durable goods	86.7	87.3	87.5
Capital goods	81.9	82.0	81.9
Electric and electrical generating equipment	91.2	91.6	91.7
Nonelectrical machinery	78.7	78.8	78.6

Automotive vehicles; parts, and engines	101.9	101.9	102.0
Consumer goods, excluding automotive	97.4	97.7	97.5
Nondurables, manufactured	100.3	100.8	100.5
Durables, manufactured	94.1	94.2	94.1
Nonmanufactured consumer goods	99.1	99.9	100.0

	1999		2000
Category	Nov.	Dec.	Jan.
ALL COMMODITIES	96.2	96.8	97.2
Foods, feeds, and beverages	93.0	94.8	93.6
Agricultural foods, feeds, and beverages	87.2	89.8	88.4
Nonagricultural (fish, beverages) food products	108.2	107.7	107.2
Industrial supplies and materials	106.9	109.4	111.0
Fuels and lubricants	134.3	140.7	144.2
Petroleum and petroleum products	132.5	140.9	145.8
Paper and paper base stocks	81.8	81.2	82.1
Materials associated with nondurable supplies and materials	88.8	89.1	89.2
Selected building materials	108.3	111.1	110.5
Unfinished metals associated with durable goods	94.4	94.8	97.4
Nonmetals associated with durable goods	87.5	87.4	87.2
Capital goods	81.8	81.7	81.7
Electric and electrical generating equipment	91.8	91.1	91.8
Nonelectrical machinery	78.5	78.4	78.3
Automotive vehicles; parts, and engines	102.0	102.0	102.1
Consumer goods, excluding automotive	97.6	97.5	97.5
Nondurables, manufactured	100.7	100.6	100.4
Durables, manufactured	94.2	94.1	94.1
Nonmanufactured consumer goods	98.8	99.8	101.5

		2000	
Category	Feb.	Mar.	Apr.
ALL COMMODITIES	99.2	99.3	97.9
Foods, feeds, and beverages	93.3	92.5	93.3
Agricultural foods, feeds,			

and beverages	87.6	86.6	86.7
Nonagricultural (fish, beverages) food products	108.1	108.3	110.8
Industrial supplies and materials	118.6	119.8	114.3
Fuels and lubricants	164.7	163.7	147.7
Petroleum and petroleum products	167.5	166.2	147.4
Paper and paper base stocks	82.8	83.1	85.6
Materials associated with nondurable supplies and materials	89.7	90.4	91.2
Selected building materials	110.1	112.1	111.9
Unfinished metals associated with durable goods	100.3	107.1	104.3
Nonmetals associated with durable goods	88.0	87.6	87.8
Capital goods	81.6	81.3	81.4
Electric and electrical generating equipment	91.8	92.1	93.9
Nonelectrical machinery	78.2	77.9	77.7
Automotive vehicles; parts, and engines	102.2	102.2	102.3
Consumer goods, excluding automotive	97.4	97.1	97.1
Nondurables, manufactured	100.4	100.3	100.3
Durables, manufactured	93.8	93.5	93.4
Nonmanufactured consumer goods	102.0	100.1	100.3

		2000	
Category	May	June	July
ALL COMMODITIES	98.3	99.6	99.6
Foods, feeds, and beverages	91.9	91.1	91.1
Agricultural foods, feeds, and beverages	85.2	84.1	83.7
Nonagricultural (fish, beverages) food products	109.8	109.7	110.5
Industrial supplies and materials	115.9	121.8	121.7
Fuels and lubricants	153.3	170.6	169.0
Petroleum and petroleum products	154.0	170.4	167.7
Paper and paper base stocks	86.8	87.0	87.5
Materials associated with nondurable supplies and materials	92.1	91.7	92.7
Selected building materials	109.1	105.0	103.4
Unfinished metals associated with durable goods	102.0	105.0	106.5

Nonmetals associated with durable goods	87.8	87.0	87.7
Capital goods	81.2	80.9	80.9
Electric and electrical generating equipment	94.2	94.3	94.1
Nonelectrical machinery	77.5	77.1	77.1
Automotive vehicles; parts, and engines	102.6	102.7	102.9
Consumer goods, excluding automotive	97.0	96.5	96.8
Nondurables, manufactured	100.1	99.5	99.8
Durables, manufactured	93.4	93.2	93.4
Nonmanufactured consumer goods	99.7	98.0	99.5

	2000
Category	Aug.
ALL COMMODITIES	99.8
Foods, feeds, and beverages	91.5
Agricultural foods, feeds, and beverages	83.2
Nonagricultural (fish, beverages) food products	113.4
Industrial supplies and materials	122.4
Fuels and lubricants	170.0
Petroleum and petroleum products	167.8
Paper and paper base stocks	87.6
Materials associated with nondurable supplies and materials	92.8
Selected building materials	100.2
Unfinished metals associated with durable goods	109.5
Nonmetals associated with durable goods	87.5
Capital goods	80.7
Electric and electrical generating equipment	93.7
Nonelectrical machinery	77.0
Automotive vehicles; parts, and engines	102.7
Consumer goods, excluding automotive	96.8
Nondurables, manufactured	100.0
Durables, manufactured	93.2
Nonmanufactured consumer goods	99.2

38. U.S. international price Indexes for selected categories of

services

(1990 = 100, unless otherwise indicated)

Category	1998 Dec.	1999 Mar.	1999 June	1999 Sept.	1999 Dec.
Air freight (inbound) (9/90 = 100)	87.4	88.0	86.2	87.9	90.7
Air freight (outbound) (9/92 = 100)	95.2	92.7	92.8	92.7	91.7
Air passenger fares (U.S. carriers)	103.1	104.5	112.3	114.2	106.8
Air passenger fares (foreign carriers)	101.1	98.9	106.3	108.6	102.2
Ocean liner freight (inbound)	104.2	102.6	133.7	148.0	139.4

Category	2000 Mar.	2000 June	2000 Sept.
Air freight (inbound) (9/90 = 100)	88.9	88.4	88.5
Air freight (outbound) (9/92 = 100)	91.7	92.8	92.6
Air passenger fares (U.S. carriers)	107.3	113.3	115.5
Air passenger fares (foreign carriers)	102.6	107.9	109.1
Ocean liner freight (inbound)	136.3	143.0	142.8

39. Indexes of productivity, hourly compensation, and unit costs, quarterly data seasonally adjusted

(1992 = 100)

Item	Quarterly indexes 1997 II	III	IV
Business			
Output per hour of all persons	107.3	108.3	108.5
Compensation per hour	112.3	113.5	115.3
Real compensation per hour	99.8	100.4	101.5
Unit labor costs	104.7	104.8	106.3
Unit nonlabor payments	118.0	118.5	116.8
Implicit price deflator	109.6	109.9	110.2
Nonfarm business			
Output per hour of all persons	107.1	108.0	108.1
Compensation per hour	112.0	113.0	114.7
Real compensation per hour	99.5	100.0	101.0
Unit labor costs	104.5	104.7	106.1
Unit nonlabor payments	118.8	119.5	117.8
Implicit price deflator	109.7	110.1	110.4
Nonfinancial corporations			
Output per hour of all employees	109.3	110.8	111.6
Compensation per hour	111.1	112.1	113.7
Real compensation per hour	98.7	99.2	100.1

Total unit costs	101.6	101.1	101.5
Unit labor costs	101.6	101.2	101.9
Unit nonlabor costs	101.4	100.8	100.4
Unit profits	155.3	160.3	156.5
Unit nonlabor payments	115.1	116.0	114.7
Implicit price deflator	106.1	106.1	106.1
Manufacturing persons			
Output per hour of all persons	116.3	118.7	120.1
Compensation per hour	110.5	111.5	113.3
Real compensation per hour	98.1	98.6	99.8
Unit labor costs	95.0	93.9	94.4

Item	Quarterly indexes 1998 I	II	III
Business			
Output per hour of all persons	109.7	110.0	110.6
Compensation per hour	117.1	118.5	120.0
Real compensation per hour	102.9	103.8	104.7
Unit labor costs	106.7	107.7	108.5
Unit nonlabor payments	116.4	115.1	114.6
Implicit price deflator	110.3	110.5	110.7
Nonfarm business			
Output per hour of all persons	109.3	109.8	110.3
Compensation per hour	116.4	117.9	119.4
Real compensation per hour	102.3	103.2	104.2
Unit labor costs	106.5	107.5	108.3
Unit nonlabor payments	117.4	116.3	115.8
Implicit price deflator	110.5	110.7	111.0
Nonfinancial corporations			
Output per hour of all employees	112.3	113.4	114.9
Compensation per hour	115.2	116.6	118.0
Real compensation per hour	101.2	102.1	103.0
Total unit costs	102.0	102.3	102.1
Unit labor costs	102.6	102.8	102.7
Unit nonlabor costs	100.5	100.9	100.2
Unit profits	150.4	147.2	151.4
Unit nonlabor payments	113.2	112.7	113.3
Implicit price deflator	106.1	106.1	106.2
Manufacturing persons			
Output per hour of all persons	121.3	122.7	125.1
Compensation per hour	115.2	116.6	118.1
Real compensation per hour	101.2	102.1	103.0
Unit labor costs	95.0	95.1	94.4

Item	Quarterly indexes 1998 IV	1999 I	II
Business			

Output per hour of all persons	111.6	112.6	112.8
Compensation per hour	121.4	123.0	124.5
Real compensation per hour	105.5	106.4	106.9
Unit labor costs	108.8	109.3	110.4
Unit nonlabor payments	114.6	115.1	114.1
Implicit price deflator	110.9	111.4	111.8
Nonfarm business			
Output per hour of all persons	111.2	112.0	112.1
Compensation per hour	120.8	122.1	123.6
Real compensation per hour	104.9	105.7	106.1
Unit labor costs	108.5	109.0	110.2
Unit nonlabor payments	115.8	116.7	115.7
Implicit price deflator	111.2	111.8	112.2
Nonfinancial corporations			
Output per hour of all employees	115.8	117.1	118.2
Compensation per hour	119.3	120.9	122.4
Real compensation per hour	103.7	104.6	105.1
Total unit costs	102.6	102.5	103.0
Unit labor costs	103.0	103.2	103.5
Unit nonlabor costs	101.6	100.7	101.4
Unit profits	144.5	149.7	147.5
Unit nonlabor payments	112.5	113.2	113.2
Implicit price deflator	106.2	106.5	106.7
Manufacturing persons			
Output per hour of all persons	126.8	128.9	130.4
Compensation per hour	119.4	120.7	122.4
Real compensation per hour	103.7	104.4	105.1
Unit labor costs	94.1	93.6	93.8

Item	Quarterly indexes			
	1999		2000	
	III	IV	I	II
Business				
Output per hour of all persons	114.2	116.3	116.7	118.6
Compensation per hour	126.1	127.3	128.4	130.4
Real compensation per hour	107.6	107.8	107.7	108.5
Unit labor costs	110.5	109.5	110.0	110.0
Unit nonlabor payments	114.3	116.8	118.2	120.2
Implicit price deflator	111.9	112.2	113.0	113.7
Nonfarm business				
Output per hour of all persons	113.6	115.8	116.3	118.0
Compensation per hour	125.2	126.5	127.8	129.4
Real compensation per hour	106.8	107.2	107.2	107.7
Unit labor costs	110.3	109.3	109.8	109.7
Unit nonlabor payments	116.1	118.6	120.1	122.1
Implicit price deflator	112.4	112.7	113.6	114.2
Nonfinancial corporations				
Output per hour of all employees	119.7	121.5	122.3	123.8

Compensation per hour	124.0	125.3	126.1	127.8
Real compensation per hour	105.8	106.1	105.8	106.3
Total unit costs	103.2	103.0	103.1	103.4
Unit labor costs	103.6	103.1	103.1	103.2
Unit nonlabor costs	102.1	102.5	103.3	103.8
Unit profits	143.3	145.7	150.9	155.7
Unit nonlabor payments	112.6	113.5	115.4	117.0
Implicit price deflator	106.6	106.6	107.2	107.8
Manufacturing persons				
Output per hour of all persons	131.9	135.1	137.7	139.5
Compensation per hour	124.1	125.5	127.0	128.0
Real compensation per hour	105.9	106.4	106.5	106.5
Unit labor costs	94.1	92.9	92.2	91.7

40. Annual indexes of multifactor productivity and related measures, selected years

(1996 = 100, unless otherwise indicated)

Item	1960	1970	1980
Private business			
Productivity:			
Output per hour of all persons	45.6	63.0	75.8
Output per unit of capital services	110.4	111.1	101.5
Multifactor productivity	65.2	80.0	88.3
Output	27.5	42.0	59.4
Inputs:			
Labor input	54.0	61.0	71.9
Capital services	24.9	37.8	58.6
Combined units of labor and capital input	42.3	52.4	67.3
Capital per hour of all persons	41.3	56.7	74.7
Private nonfarm business			
Productivity:			
Output per hour of all persons	48.7	64.9	77.3
Output per unit of capital services	120.1	118.3	105.7
Multifactor productivity	69.1	82.6	90.5
Output	27.2	41.9	59.6
Inputs:			
Labor input	50.1	59.3	70.7
Capital services	22.6	35.5	56.4
Combined units of labor and capital input	39.3	50.7	65.9
Capital per hour of all persons	40.5	54.8	73.1
Manufacturing (1992 = 100)			
Productivity:			
Output per hour of all persons	41.8	54.2	70.1
Output per unit of capital services	124.3	116.5	100.9
Multifactor productivity	72.7	84.4	86.6
Output	38.5	56.5	75.3
Inputs:			
Hours of all persons	92.0	104.2	107.5
Capital services	30.9	48.5	74.7
Energy	51.3	85.4	92.5
Nonenergy materials	38.2	44.8	75.0
Purchased business services	28.2	48.8	73.7
Combined units of all factor inputs	52.9	67.0	87.0

Item	1990	1991	1992

Item			
Private business			
Productivity:			
Output per hour of all persons	90.2	91.3	94.8
Output per unit of capital services	99.3	96.1	97.7
Multifactor productivity	95.3	94.4	96.6
Output	83.6	82.6	85.7
Inputs:			
Labor input	89.4	88.3	89.3
Capital services	84.2	86.0	87.7
Combined units of labor and capital input	87.7	87.5	88.8
Capital per hour of all persons	90.8	95.0	97.0
Private nonfarm business			
Productivity:			
Output per hour of all persons	90.3	91.4	94.8
Output per unit of capital services	100.0	96.6	97.9
Multifactor productivity	95.6	94.7	96.6
Output	83.5	82.5	85.5
Inputs:			
Labor input	89.2	88.0	89.0
Capital services	83.5	85.4	87.3
Combined units of labor and capital input	87.3	87.1	88.4
Capital per hour of all persons	90.3	94.7	96.8
Manufacturing (1992 = 100)			
Productivity:			
Output per hour of all persons	92.8	95.0	100.0
Output per unit of capital services	101.6	97.5	100.0
Multifactor productivity	99.3	98.3	100.0
Output	97.3	95.4	100.0
Inputs:			
Hours of all persons	104.8	100.4	100.0
Capital services	95.8	97.9	100.0
Energy	99.9	100.1	100.0
Nonenergy materials	92.5	93.6	100.0
Purchased business services	92.5	92.1	100.0
Combined units of all factor inputs	98.0	97.0	100.0

Item	1993	1994	1995
Private business			
Productivity:			
Output per hour of all persons	95.4	96.6	97.3
Output per unit of capital services	98.5	100.3	99.7
Multifactor productivity	97.1	98.1	98.4
Output	88.5	92.8	95.8
Inputs:			
Labor input	91.8	95.6	98.0
Capital services	89.8	92.6	96.0
Combined units of labor and capital input	91.1	94.6	97.3
Capital per hour of all persons	96.8	96.3	97.6
Private nonfarm business			
Productivity:			
Output per hour of all persons	95.3	96.5	97.5
Output per unit of capital services	98.8	100.3	99.9

Multifactor productivity	97.1	98.1	98.6
Output	88.4	92.6	95.8
Inputs:			
Labor input	91.8	95.4	97.8
Capital services	89.5	92.3	95.9
Combined units of labor and capital input	91.0	94.4	97.2
Capital per hour of all persons	96.5	96.3	97.6
Manufacturing (1992 = 100)			
Productivity:			
Output per hour of all persons	101.9	105.0	109.0
Output per unit of capital services	101.1	104.0	105.0
Multifactor productivity	100.4	102.6	105.0
Output	103.3	108.7	113.4
Inputs:			
Hours of all persons	101.4	103.6	104.0
Capital services	102.2	104.5	108.0
Energy	103.7	107.3	109.5
Nonenergy materials	105.7	111.3	112.8
Purchased business services	103.0	105.1	110.0
Combined units of all factor inputs	102.9	106.0	107.9

Item	1996	1997	1998
Private business			
Productivity:			
Output per hour of all persons	100.0	102.0	104.8
Output per unit of capital services	100.0	100.5	100.1
Multifactor productivity	100.0	101.1	102.6
Output	100.0	105.2	110.6
Inputs:			
Labor input	100.0	103.7	106.4
Capital services	100.0	104.7	110.4
Combined units of labor and capital input	100.0	104.0	107.7
Capital per hour of all persons	100.0	101.5	104.7
Private nonfarm business			
Productivity:			
Output per hour of all persons	100.0	101.7	104.5
Output per unit of capital services	100.0	100.2	99.8
Multifactor productivity	100.0	100.9	102.4
Output	100.0	105.1	110.6
Inputs:			
Labor input	100.0	103.8	106.6
Capital services	100.0	104.9	110.8
Combined units of labor and capital input	100.0	104.2	108.0
Capital per hour of all persons	100.0	101.5	104.7
Manufacturing (1992 = 100)			
Productivity:			
Output per hour of all persons	112.8	117.1	124.3
Output per unit of capital services	104.5	105.6	106.5
Multifactor productivity	106.1	109.8	113.2
Output	116.9	123.5	130.7
Inputs:			
Hours of all persons	103.7	105.5	105.2
Capital services	111.9	116.9	122.8
Energy	107.0	103.9	109.2

Nonenergy materials	120.4	120.4	127.2
Purchased business services	108.9	114.2	116.8
Combined units of all factor inputs	110.2	112.5	115.5

41. Annual indexes of productivity, hourly compensation, unit costs, and prices, selected years

(1992 = 100)

Item	1960	1970	1980	1989
Business				
Output per hour of all persons	48.8	67.0	80.4	93.9
Compensation per hour	13.7	23.5	54.2	85.8
Real compensation per hour	60.0	78.9	89.5	95.9
Unit labor costs	28.0	35.1	67.4	91.3
Unit nonlabor payments	25.2	31.6	61.5	91.8
Implicit price deflator	27.0	33.9	65.2	91.5
Nonfarm business				
Output per hour of all persons	51.9	68.9	82.0	94.2
Compensation per hour	14.3	23.7	54.6	85.8
Real compensation per hour	62.8	79.5	90.0	95.9
Unit labor costs	27.5	34.4	66.5	91.1
Unit nonlabor payments	24.6	31.3	60.5	91.3
Implicit price deflator	26.5	33.3	64.3	91.2
Nonfinancial corporations				
Output per hour of all employees	55.4	70.4	81.1	94.6
Compensation per hour	15.6	25.3	56.4	86.2
Real compensation per hour	68.3	84.7	93.1	96.3
Total unit costs	26.8	34.8	68.4	92.0
Unit labor costs	28.1	35.9	69.6	91.1
Unit nonlabor costs	23.3	31.9	65.1	94.6
Unit profits	50.2	44.4	68.8	97.3
Unit nonlabor payments	30.2	35.1	66.0	95.3
Implicit price deflator	28.8	35.6	68.4	92.5
Manufacturing				
Output per hour of all persons	41.9	54.3	70.3	90.5
Compensation per hour	14.9	23.7	55.6	86.6
Real compensation per hour	65.2	79.5	91.7	96.8
Unit labor costs	35.5	43.7	79.1	95.8
Unit nonlabor payments	26.8	29.4	80.2	95.4
Implicit price deflator	30.2	34.9	79.8	95.5

Item	1990	1991	1993
Business			
Output per hour of all persons	95.2	96.3	100.5
Compensation per hour	90.7	95.0	102.5
Real compensation per hour	96.5	97.5	99.9
Unit labor costs	95.3	98.7	101.9
Unit nonlabor payments	93.9	97.0	102.5
Implicit price deflator	94.8	98.1	102.2
Nonfarm business			
Output per hour of all persons	95.3	96.4	100.5
Compensation per hour	90.5	95.0	102.2

Real compensation per hour	96.3	97.5	99.6
Unit labor costs	95.0	98.5	101.7
Unit nonlabor payments	93.6	97.1	103.0
Implicit price deflator	94.5	98.0	102.2
Nonfinancial corporations			
Output per hour of all employees	95.4	97.6	100.8
Compensation per hour	90.8	95.2	102.1
Real compensation per hour	96.6	97.8	99.6
Total unit costs	95.9	98.8	101.0
Unit labor costs	95.2	97.5	101.3
Unit nonlabor costs	98.0	102.1	100.2
Unit profits	94.3	93.0	113.2
Unit nonlabor payments	97.1	99.7	103.5
Implicit price deflator	95.8	98.3	102.1
Manufacturing			
Output per hour of all persons	92.9	95.0	102.0
Compensation per hour	90.8	95.6	102.7
Real compensation per hour	98.6	98.1	100.2
Unit labor costs	97.7	100.6	100.7
Unit nonlabor payments	99.6	98.9	101.0
Implicit price deflator	98.9	99.6	100.9

Item	1994	1995	1996
Business			
Output per hour of all persons	101.9	102.6	105.4
Compensation per hour	104.5	106.7	110.1
Real compensation per hour	99.7	99.3	99.7
Unit labor costs	102.6	104.1	104.5
Unit nonlabor payments	106.4	109.4	113.3
Implicit price deflator	104.0	106.0	107.7
Nonfarm business			
Output per hour of all persons	101.8	102.8	105.4
Compensation per hour	104.3	106.6	109.8
Real compensation per hour	99.5	99.2	99.5
Unit labor costs	102.5	103.7	104.2
Unit nonlabor payments	106.9	110.4	113.5
Implicit price deflator	104.1	106.1	107.6
Nonfinancial corporations			
Output per hour of all employees	103.2	104.3	107.6
Compensation per hour	104.3	106.2	109.1
Real compensation per hour	99.5	98.9	98.9
Total unit costs	101.1	102.0	101.2
Unit labor costs	101.0	101.9	101.4
Unit nonlabor costs	101.3	102.2	100.6
Unit profits	131.7	139.0	152.2
Unit nonlabor payments	109.0	111.6	113.8
Implicit price deflator	103.7	105.1	105.5
Manufacturing			
Output per hour of all persons	105.2	109.3	113.1
Compensation per hour	105.6	107.9	109.3

Real compensation per hour	100.8	100.4	99.0
Unit labor costs	100.4	98.7	96.6
Unit nonlabor payments	102.9	107.2	110.1
Implicit price deflator	101.9	103.9	104.9

Item	1997	1998	1999
Business			
Output per hour of all persons	107.6	110.5	114.0
Compensation per hour	113.3	119.3	125.2
Real compensation per hour	100.4	104.3	107.3
Unit labor costs	105.3	107.9	109.9
Unit nonlabor payments	117.1	115.2	115.1
Implicit price deflator	109.7	110.6	111.8
Nonfarm business			
Output per hour of all persons	107.3	110.2	113.4
Compensation per hour	112.9	118.6	124.4
Real compensation per hour	100.0	103.8	106.5
Unit labor costs	105.1	107.7	109.7
Unit nonlabor payments	118.0	116.3	116.8
Implicit price deflator	109.8	110.8	112.3
Nonfinancial corporations			
Output per hour of all employees	110.2	114.2	119.2
Compensation per hour	112.0	117.4	123.2
Real compensation per hour	99.3	102.7	105.5
Total unit costs	101.4	102.2	102.9
Unit labor costs	101.6	102.8	103.4
Unit nonlabor costs	100.8	100.8	101.7
Unit profits	156.7	148.3	146.5
Unit nonlabor payments	115.0	112.9	113.1
Implicit price deflator	106.1	106.1	106.6
Manufacturing			
Output per hour of all persons	117.6	123.9	131.6
Compensation per hour	111.4	117.3	123.2
Real compensation per hour	98.8	102.6	105.5
Unit labor costs	94.8	94.6	93.6
Unit nonlabor payments	109.7	104.6	--
Implicit price deflator	103.9	100.7	--

42. Annual indexes of output per hour for selected 3-digit SIC industries
(1987 = 100)

Industry	SIC	1998
Mining		
Copper ores	102	109.2
Gold and silver ores	104	101.5
Bituminous coal and lignite mining	122	111.7
Crude petroleum and natural gas	131	101.0
Crushed and broken stone	142	101.3
Manufacturing		
Meat products	201	100.1
Dairy products	202	108.4

Preserved fruits and vegetables	203	97.0
Grain mill products	204	101.3
Bakery products	205	96.8
Sugar and confectionery products	206	99.5
Fats and oils	207	108.9
Beverages	208	106.0
Miscellaneous food and kindred products	209	107.0
Cigarettes	211	101.2
Broadwoven fabric mills, cotton	221	99.6
Broadwoven fabric mills, manmade	222	99.2
Narrow fabric mills	224	108.4
Knitting mills	225	96.3
Textile finishing, except wool	226	90.3
Carpets and rugs	227	96.8
Yarn and thread mills	228	102.1
Miscellaneous textile goods	229	101.6
Men's and boys' suits and coats	231	105.1
Men's and boys' furnishings	232	100.1
Women's and misses' outerwear	233	101.4
Women's and children's undergarments	234	105.4
Hats, caps, and millinery	235	99.0
Miscellaneous apparel and accessories	238	101.3
Miscellaneous fabricated textile products	239	96.6
Logging	241	93.7
Sawmills and planing mills	242	100.7
Millwork, plywood, and structural members	243	98.8
Wood containers	244	103.1
Wood buildings and mobile homes	245	97.8
Miscellaneous wood products	249	95.9
Household furniture	251	99.4
Office furniture	252	94.3
Public building and related furniture	253	109.6
Partitions and fixtures	254	95.7
Miscellaneous furniture and fixtures	259	103.6
Pulp mills	261	99.6
Paper mills	262	103.9
Paperboard mills	263	105.5
Paperboard containers and boxes	265	99.7
Miscellaneous converted paper products	267	101.1
Newspapers	271	96.9
Periodicals	272	97.9
Books	273	99.1
Miscellaneous publishing	274	96.7
Commercial printing	275	100.0
Manifold business forms	276	98.7

Greeting cards	277	100.1
Blankbooks and bookbinding	278	95.6
Printing trade services	279	99.9
Industrial inorganic chemicals	281	105.7
Plastics materials and synthetics	282	98.8
Drugs	283	101.0
Soaps, cleaners, and toilet goods	284	102.0
Paints and allied products	285	101.4
Industrial organic chemicals	286	109.9
Agricultural chemicals	287	103.7
Miscellaneous chemical products	289	95.4
Petroleum refining	291	105.3
Asphalt paving and roofing materials	295	98.3
Miscellaneous petroleum and coal products	299	98.4
Tires and inner tubes	301	102.9
Hose and belting and gaskets and packing	305	103.7
Fabricated rubber products, n.e.c.	306	104.2
Miscellaneous plastics products, n.e.c.	308	100.5
Footwear, except rubber	314	101.3
Luggage	316	93.7
Handbags and personal leather goods	317	98.5
Flat glass	321	91.9
Glass and glassware, pressed or blown	322	100.6
Products of purchased glass	323	95.9
Cement, hydraulic	324	103.2
Structural clay products	325	98.8
Pottery and related products	326	99.6
Concrete, gypsum, and plaster products	327	100.8
Miscellaneous nonmetallic mineral products	329	103.0
Blast furnace and basic steel products	331	112.6
Iron and steel foundries	332	134.0
Primary nonferrous metals	333	107.8
Nonferrous rolling and drawing	335	95.5
Nonferrous foundries (castings)	336	102.6
Miscellaneous primary metal products	339	106.8
Metal cans and shipping containers	341	106.5
Cutlery, handtools, and hardware	342	97.6
Plumbing and heating, except electric	343	103.7
Fabricated structural metal products	344	100.4
Screw machine products, bolts, etc.	345	98.5
Metal forgings and stampings	346	101.5
Metal services, n.e.c.	347	108.3
Ordnance and accessories, n.e.c.	348	97.7

Miscellaneous fabricated metal products	349	101.4
Engines and turbines	351	106.8
Farm and garden machinery	352	106.3
Construction and related machinery	353	106.5
Metalworking machinery	354	101.0
Special industry machinery	355	104.6
General industrial machinery	356	105.9
Refrigeration and service machinery	358	102.1
Industrial machinery, n.e.c.	359	106.5
Electric distribution equipment	361	105.4
Electrical industrial apparatus	362	104.6
Household appliances	363	103.0
Electric lighting and wiring equipment	364	101.9
Communications equipment	366	110.5
Miscellaneous electrical equipment & supplies	369	102.8
Motor vehicles and equipment	371	103.2
Aircraft and parts	372	100.6
Ship and boat building and repairing	373	99.4
Railroad equipment	374	113.5
Motorcycles, bicycles, and parts	375	92.6
Guided missiles, space vehicles, parts	376	104.1
Search and navigation equipment	381	104.8
Measuring and controlling devices	382	103.9
Medical instruments and supplies	364	105.2
Ophthalmic goods	365	112.6
Photographic equipment & supplies	386	105.6
Jewelry, silverware, and plated ware	391	100.1
Musical instruments	393	101.8
Toys and sporting goods	394	104.8
Pens, pencils, office, and art supplies	395	108.3
Costume jewelry and notions	396	102.0
Miscellaneous manufactures	399	102.1
Transportation		
Trucking, except local(1)	4213	105.2
U.S. postal service(2)	431	99.9
Air transportation(1)	512,13,22 (pts.)	99.5
Utilities		
Telephone communications	481	106.2
Radio and television broadcasting	483	103.1
Cable and other pay TV services	484	102.0
Electric utilities	491,3 (pt.)	104.9
Gas utilities	492,3 (pt.)	108.3

Trade		
Lumber and other building materials dealers	521	101.0
Paint, glass, and wallpaper stores	523	102.8
Hardware stores	525	108.6
Retail nurseries, lawn and garden supply store	526	106.7
Department stores	531	99.2
Variety stores	533	101.9
Miscellaneous general merchandise stores	539	100.8
Grocery stores	541	98.9
Meat and fish (seafood) markets	542	99.0
Retail bakeries	546	89.8
New and used car dealers	551	103.4
Auto and home supply stores	553	103.2
Gasoline service stations	554	103.0
Men's and boys' wear stores	561	106.0
Women's clothing stores	562	97.8
Family clothing stores	565	102.0
Shoe stores	566	102.7
Miscellaneous apparel and accessory stores	569	96.3
Furniture and homefurnishings stores	571	98.6
Household appliance stores	572	98.5
Radio, television, computer, and music stores	573	118.6
Eating and drinking places	581	102.8
Drug and proprietary stores	591	101.9
Liquor stores	592	98.2
Used merchandise stores	593	105.3
Miscellaneous shopping goods stores	594	100.7
Nonstore retailers	596	105.6
Fuel dealers	598	95.6
Retail stores, n.e.c.	599	105.9
Finance and services		
Commercial banks	602	102.8
Hotels and motels	701	97.6
Laundry, cleaning, and garment services	721	97.2
Photographic studios, portrait	722	100.1
Beauty shops	723	95.1
Barber shops	724	108.8
Funeral services and crematories	726	102.5
Automotive repair shops	753	105.7
Motion picture theaters	783	107.1

Industry	1989	1990	1991
Mining			
Copper ores	106.6	102.7	100.5

Gold and silver ores	113.3	122.3	127.4
Bituminous coal and lignite mining	117.3	118.7	122.4
Crude petroleum and natural gas	98.0	97.0	97.9
Crushed and broken stone	98.7	102.2	99.8
Manufacturing			
Meat products	99.2	97.1	99.6
Dairy products	107.7	107.3	108.3
Preserved fruits and vegetables	97.8	95.6	99.2
Grain mill products	107.6	105.4	104.9
Bakery products	96.1	92.7	90.6
Sugar and confectionery products	101.8	103.2	102.0
Fats and oils	116.4	118.1	120.1
Beverages	112.7	117.7	120.5
Miscellaneous food and kindred products	99.3	99.3	101.6
Cigarettes	109.0	113.2	107.6
Broadwoven fabric mills, cotton	99.8	103.1	111.2
Broadwoven fabric mills, manmade	106.3	111.3	116.2
Narrow fabric mills	92.7	96.5	99.6
Knitting mills	108.0	107.5	114.1
Textile finishing, except wool	88.7	83.4	79.9
Carpets and rugs	97.8	93.2	892.0
Yarn and thread mills	104.2	110.2	111.4
Miscellaneous textile goods	109.1	109.2	104.6
Men's and boys' suits and coats	97.7	93.9	90.2
Men's and boys' furnishings	100.1	102.1	108.4
Women's and misses' outerwear	96.8	104.1	104.3
Women's and children's undergarments	94.6	102.1	113.6
Hats, caps, and millinery	96.4	89.2	91.1
Miscellaneous apparel and accessories	88.4	90.6	91.8
Miscellaneous fabricated textile products	95.7	99.9	100.7
Logging	89.4	86.3	86.0
Sawmills and planing mills	99.6	99.8	102.6
Millwork, plywood, and structural members	97.1	960.0	98.0
Wood containers	108.8	111.2	113.1
Wood buildings and mobile homes	98.8	103.1	103.0
Miscellaneous wood products	102.4	107.7	110.5
Household furniture	102.0	104.5	107.1
Office furniture	97.5	95.0	94.1
Public building and related furniture	113.7	119.8	120.2
Partitions and fixtures	92.4	95.6	93.0
Miscellaneous furniture and fixtures	101.9	103.5	102.1
Pulp mills	107.4	116.7	128.3
Paper mills	103.6	102.3	99.2
Paperboard mills	101.9	100.6	101.4
Paperboard containers and boxes	101.5	101.3	103.4

Miscellaneous converted paper products	101.6	101.4	105.3
Newspapers	95.2	90.6	85.8
Periodicals	98.3	93.9	89.5
Books	94.1	96.6	100.8
Miscellaneous publishing	89.0	92.2	95.9
Commercial printing	101.1	102.5	102.0
Manifold business forms	89.7	93.0	89.1
Greeting cards	109.1	100.6	92.7
Blankbooks and bookbinding	94.2	99.4	96.1
Printing trade services	94.3	99.3	100.6
Industrial inorganic chemicals	104.3	106.8	109.7
Plastics materials and synthetics	99.7	100.9	100.0
Drugs	102.8	103.8	104.5
Soaps, cleaners, and toilet goods	100.6	103.8	105.3
Paints and allied products	103.3	106.3	104.3
Industrial organic chemicals	110.4	101.4	95.8
Agricultural chemicals	104.3	104.7	99.5
Miscellaneous chemical products	95.2	97.3	96.1
Petroleum refining	109.6	109.2	106.6
Asphalt paving and roofing materials	95.3	98.0	94.1
Miscellaneous petroleum and coal products	101.9	94.8	90.6
Tires and inner tubes	103.8	103.0	102.4
Hose and belting and gaskets and packing	96.3	96.1	92.4
Fabricated rubber products, n.e.c.	105.5	109.0	109.9
Miscellaneous plastics products, n.e.c.	101.8	105.7	108.2
Footwear, except rubber	101.1	101.1	94.4
Luggage	104.8	106.2	100.3
Handbags and personal leather goods	93.1	96.5	98.7
Flat glass	90.7	84.5	83.6
Glass and glassware, pressed or blown	100.2	104.8	102.3
Products of purchased glass	90.1	92.6	97.7
Cement, hydraulic	110.2	112.4	108.3
Structural clay products	103.1	109.6	109.8
Pottery and related products	97.1	98.6	95.8
Concrete, gypsum, and plaster products	102.4	102.3	101.2
Miscellaneous nonmetallic mineral products	95.5	95.4	94.0
Blast furnace and basic steel products	108.0	109.6	107.8
Iron and steel foundries	105.4	106.1	104.5
Primary nonferrous metals	106.1	102.3	110.7
Nonferrous rolling and drawing	93.6	92.7	91.0
Nonferrous foundries (castings)	105.1	104.0	103.6
Miscellaneous primary metal products	105.0	113.7	109.1
Metal cans and shipping containers	108.5	117.6	122.9
Cutlery, handtools, and hardware	101.7	97.3	96.8

Plumbing and heating, except electric	101.5	102.6	102.0
Fabricated structural metal products	96.9	98.8	100.0
Screw machine products, bolts, etc.	96.1	96.1	97.9
Metal forgings and stampings	99.8	95.6	929.0
Metal services, n.e.c.	102.4	104.7	99.4
Ordnance and accessories, n.e.c.	89.8	82.1	81.5
Miscellaneous fabricated metal products	95.9	97.5	97.4
Engines and turbines	110.7	106.5	105.8
Farm and garden machinery	110.7	116.5	112.9
Construction and related machinery	108.3	107.0	99.1
Metalworking machinery	103.5	101.1	96.4
Special industry machinery	108.3	107.5	108.3
General industrial machinery	101.5	101.5	101.6
Refrigeration and service machinery	106.0	103.6	100.7
Industrial machinery, n.e.c.	107.1	107.3	109.0
Electric distribution equipment	105.0	106.3	106.5
Electrical industrial apparatus	107.4	107.7	107.1
Household appliances	104.7	105.8	106.5
Electric lighting and wiring equipment	100.2	99.9	97.5
Communications equipment	107.2	121.4	124.5
Miscellaneous electrical equipment & supplies	99.6	90.6	98.6
Motor vehicles and equipment	103.3	102.4	96.6
Aircraft and parts	98.2	98.9	108.2
Ship and boat building and repairing	97.6	103.7	96.3
Railroad equipment	135.3	141.1	146.9
Motorcycles, bicycles, and parts	94.6	93.6	99.8
Guided missiles, space vehicles, parts	110.6	116.5	110.5
Search and navigation equipment	105.8	112.7	118.9
Measuring and controlling devices	102.1	107.0	113.9
Medical instruments and supplies	107.9	116.9	118.7
Ophthalmic goods	123.3	121.2	125.1
Photographic equipment & supplies	113.0	107.8	110.2
Jewelry, silverware, and plated ware	102.9	99.3	95.8
Musical instruments	96.1	97.1	96.9
Toys and sporting goods	106.0	108.1	109.7
Pens, pencils, office, and art supplies	112.9	118.2	116.8
Costume jewelry and notions	93.8	105.3	106.7
Miscellaneous manufactures	100.9	106.5	109.2
Transportation			
Trucking, except local(1)	109.3	111.1	116.9
U.S. postal service(2)	99.7	104.0	103.7
Air transportation(1)	95.8	92.9	92.5

Utilities			
Telephone communications	111.6	113.3	119.8
Radio and television broadcasting	106.2	104.9	106.1
Cable and other pay TV services	99.7	92.5	87.5
Electric utilities	107.7	110.1	113.4
Gas utilities	111.2	105.8	109.6
Trade			
Lumber and other building materials dealers	99.1	103.6	101.3
Paint, glass, and wallpaper stores	101.7	106.0	99.4
Hardware stores	115.2	110.5	102.5
Retail nurseries, lawn and garden supply store	103.4	83.9	88.5
Department stores	97.0	94.2	98.2
Variety stores	124.4	151.2	154.2
Miscellaneous general merchandise stores	109.8	116.4	121.8
Grocery stores	95.4	94.6	93.7
Meat and fish (seafood) markets	97.6	96.8	88.4
Retail bakeries	83.3	89.7	94.7
New and used car dealers	102.5	106.1	104.1
Auto and home supply stores	101.6	102.7	99.0
Gasoline service stations	105.2	102.6	104.3
Men's and boys' wear stores	109.6	113.7	119.2
Women's clothing stores	99.5	101.5	103.0
Family clothing stores	104.9	104.5	106.4
Shoe stores	107.2	106.1	105.1
Miscellaneous apparel and accessory stores	95.2	88.6	78.8
Furniture and homefurnishings stores	100.9	101.8	101.5
Household appliance stores	103.5	102.8	105.2
Radio, television, computer, and music stores	114.6	119.6	128.3
Eating and drinking places	102.2	104.0	103.1
Drug and proprietary stores	102.5	103.6	104.7
Liquor stores	101.1	105.2	105.9
Used merchandise stores	104.9	100.3	98.6
Miscellaneous shopping goods stores	104.2	104.2	105.0
Nonstore retailers	110.8	108.8	109.3
Fuel dealers	92.0	84.4	85.3
Retail stores, n.e.c.	103.1	113.7	103.2
Finance and services			
Commercial banks	104.8	107.7	110.1
Hotels and motels	95.0	96.1	99.1
Laundry, cleaning, and garment services	99.7	101.8	99.2
Photographic studios, portrait	94.9	96.6	92.8
Beauty shops	99.6	96.8	94.8

Barber shops	111.6	100.2	94.1
Funeral services and crematories	97.9	90.9	89.5
Automotive repair shops	108.1	106.9	98.7
Motion picture theaters	114.3	115.8	116.0

Industry	1992	1993	1994
Mining			
Copper ores	115.2	118.1	126.0
Gold and silver ores	141.6	159.8	160.8
Bituminous coal and lignite mining	133.0	141.2	148.1
Crude petroleum and natural gas	102.1	105.9	112.4
Crushed and broken stone	105.0	103.6	108.7
Manufacturing			
Meat products	104.6	104.3	101.2
Dairy products	111.4	109.6	111.8
Preserved fruits and vegetables	100.5	106.8	107.6
Grain mill products	107.8	109.2	108.4
Bakery products	93.8	94.4	96.4
Sugar and confectionery products	99.8	104.5	106.2
Fats and oils	114.1	112.6	111.8
Beverages	127.6	127.0	130.8
Miscellaneous food and kindred products	101.6	105.3	101.0
Cigarettes	111.6	106.5	126.6
Broadwoven fabric mills, cotton	110.3	117.8	122.1
Broadwoven fabric mills, manmade	126.2	131.7	142.5
Narrow fabric mills	112.9	111.4	120.1
Knitting mills	119.5	128.1	134.3
Textile finishing, except wool	78.6	79.3	81.2
Carpets and rugs	96.1	97.1	93.3
Yarn and thread mills	119.6	126.6	130.7
Miscellaneous textile goods	106.5	110.4	118.5
Men's and boys' suits and coats	89.0	97.4	97.7
Men's and boys' furnishings	109.1	108.4	111.7
Women's and misses' outerwear	109.4	121.8	127.4
Women's and children's undergarments	117.4	124.5	138.0
Hats, caps, and millinery	93.6	87.2	77.7
Miscellaneous apparel and accessories	91.3	94.0	105.5
Miscellaneous fabricated textile products	107.5	108.5	107.8
Logging	96.2	88.6	87.8
Sawmills and planing mills	106.1	101.9	103.3
Millwork, plywood, and structural members	99.9	97.0	94.5
Wood containers	109.4	100.1	100.9
Wood buildings and mobile homes	103.1	103.8	98.3
Miscellaneous wood products	114.2	115.3	111.8
Household furniture	110.5	110.6	112.5
Office furniture	102.5	103.2	100.5
Public building and related			

furniture	140.6	161.0	157.4
Partitions and fixtures	102.7	107.4	98.9
Miscellaneous furniture and fixtures	99.5	103.6	104.7
Pulp mills	137.3	122.5	128.9
Paper mills	103.3	102.4	110.2
Paperboard mills	104.4	108.4	114.9
Paperboard containers and boxes	105.2	107.9	108.4
Miscellaneous converted paper products	105.5	107.9	110.6
Newspapers	81.5	79.4	79.9
Periodicals	92.9	89.5	81.9
Books	97.7	103.5	103.0
Miscellaneous publishing	105.8	104.5	97.5
Commercial printing	108.0	106.9	106.5
Manifold business forms	94.5	91.1	82.0
Greeting cards	96.7	91.4	89.0
Blankbooks and bookbinding	103.6	98.7	105.4
Printing trade services	112.0	115.3	111.0
Industrial inorganic chemicals	109.7	105.6	102.3
Plastics materials and synthetics	107.5	112.0	125.3
Drugs	99.5	99.9	104.9
Soaps, cleaners, and toilet goods	104.4	108.7	111.2
Paints and allied products	102.9	108.8	116.7
Industrial organic chemicals	94.6	92.2	99.9
Agricultural chemicals	99.5	103.8	105.0
Miscellaneous chemical products	101.8	107.1	105.7
Petroleum refining	111.3	120.1	123.8
Asphalt paving and roofing materials	100.4	108.0	104.9
Miscellaneous petroleum and coal products	101.5	104.2	96.3
Tires and inner tubes	107.8	116.5	124.1
Hose and belting and gaskets and packing	97.8	99.7	102.7
Fabricated rubber products, n.e.c.	115.2	123.1	119.1
Miscellaneous plastics products, n.e.c.	114.4	116.7	120.7
Footwear, except rubber	104.2	105.2	113.0
Luggage	90.7	89.5	92.3
Handbags and personal leather goods	111.2	97.8	86.8
Flat glass	92.7	97.7	97.6
Glass and glassware, pressed or blown	108.9	108.7	112.9
Products of purchased glass	101.5	106.2	105.9
Cement, hydraulic	115.1	119.9	125.6
Structural clay products	111.4	106.8	114.0
Pottery and related products	99.5	100.3	108.4
Concrete, gypsum, and plaster products	102.5	104.6	101.5
Miscellaneous nonmetallic mineral products	104.3	104.5	106.3
Blast furnace and basic steel			

products	117.1	133.5	142.4
Iron and steel foundries	107.2	112.1	113.0
Primary nonferrous metals	101.9	107.9	105.3
Nonferrous rolling and drawing	96.0	98.3	101.2
Nonferrous foundries (castings)	103.6	108.5	112.1
Miscellaneous primary metal products	114.5	111.3	134.5
Metal cans and shipping containers	127.6	132.3	140.9
Cutlery, handtools, and hardware	100.1	104.0	109.2
Plumbing and heating, except electric	98.4	102.0	109.1
Fabricated structural metal products	103.9	104.8	107.7
Screw machine products, bolts, etc.	102.3	104.4	107.2
Metal forgings and stampings	103.7	108.7	108.5
Metal services, n.e.c.	111.6	120.6	123.0
Ordnance and accessories, n.e.c.	88.6	84.6	83.6
Miscellaneous fabricated metal products	101.1	102.0	103.2
Engines and turbines	103.3	109.2	122.3
Farm and garden machinery	113.9	116.6	125.0
Construction and related machinery	102.0	108.2	117.7
Metalworking machinery	104.3	107.4	109.9
Special industry machinery	106.0	113.6	121.2
General industrial machinery	101.6	104.8	106.7
Refrigeration and service machinery	104.9	108.6	110.7
Industrial machinery, n.e.c.	117.0	118.5	127.4
Electric distribution equipment	119.6	122.2	131.8
Electrical industrial apparatus	117.1	132.9	134.9
Household appliances	115.0	123.4	131.4
Electric lighting and wiring equipment	105.7	107.8	113.4
Communications equipment	146.7	150.3	166.0
Miscellaneous electrical equipment & supplies	101.3	108.2	110.5
Motor vehicles and equipment	104.2	106.2	108.8
Aircraft and parts	112.4	115.2	109.6
Ship and boat building and repairing	102.7	106.2	103.8
Railroad equipment	147.9	151.0	152.5
Motorcycles, bicycles, and parts	106.4	130.9	125.1
Guided missiles, space vehicles, parts	110.5	122.1	118.9
Search and navigation equipment	122.1	129.1	132.1
Measuring and controlling devices	121.0	125.2	135.0
Medical instruments and supplies	123.5	127.3	126.7
Ophthalmic goods	144.5	157.8	160.6
Photographic equipment & supplies	116.4	126.9	132.7
Jewelry, silverware, and plated ware	96.7	96.7	99.5
Musical instruments	96.0	95.6	88.7
Toys and sporting goods	104.9	114.2	109.7
Pens, pencils, office, and art supplies	111.3	111.6	129.9

Costume jewelry and notions	110.8	115.8	129.0
Miscellaneous manufactures	109.5	107.7	106.1
Transportation			
Trucking, except local(1)	123.4	126.6	129.5
U.S. postal service(2)	104.5	107.1	106.6
Air transportation(1)	96.9	100.2	105.7
Utilities			
Telephone communications	127.7	135.5	142.2
Radio and television broadcasting	108.3	106.7	110.1
Cable and other pay TV services	88.3	86.7	85.6
Electric utilities	115.2	120.6	126.8
Gas utilities	111.1	121.8	125.6
Trade			
Lumber and other building materials dealers	105.4	110.5	118.3
Paint, glass, and wallpaper stores	106.5	114.7	130.2
Hardware stores	107.2	105.8	112.7
Retail nurseries, lawn and garden supply store	100.4	106.6	116.6
Department stores	100.9	105.7	108.6
Variety stores	167.7	184.7	190.1
Miscellaneous general merchandise stores	136.1	159.7	160.9
Grocery stores	93.3	92.8	92.5
Meat and fish (seafood) markets	95.8	93.7	91.1
Retail bakeries	94.0	86.5	87.2
New and used car dealers	106.5	107.6	108.7
Auto and home supply stores	100.0	98.7	102.6
Gasoline service stations	109.7	115.2	120.4
Men's and boys' wear stores	118.2	115.5	117.9
Women's clothing stores	112.2	118.4	119.3
Family clothing stores	111.7	114.5	120.4
Shoe stores	111.5	113.2	126.3
Miscellaneous apparel and accessory stores	89.1	92.9:	100.4
Furniture and homefurnishings stores	108.4	107.6	108.8
Household appliance stores	113.9	117.0	121.2
Radio, television, computer, and music stores	137.8	152.7	177.0
Eating and drinking places	102.5	102.8	101.1
Drug and proprietary stores	103.6	105.4	105.7
Liquor stores	108.4	100.7	99.1
Used merchandise stores	110.4	112.1	115.4
Miscellaneous shopping goods stores	102.7	106.5	111.9
Nonstore retailers	122.1	127.5	143.3
Fuel dealers	64.4	92.7	100.7
Retail stores, n.e.c.	111.6	117.3	125.0

Industry	1995	1996	1997	1998
Finance and services				
Commercial banks	111.0	118.5	121.7	
Hotels and motels	107.8	106.2	109.6	
Laundry, cleaning, and garment services	98.3	98.9	104.0	
Photographic studios, portrait	97.7	105.9	117.4	
Beauty shops	99.6	95.7	99.8	
Barber shops	112.1	120.8	117.7	
Funeral services and crematories	103.2	98.2	103.8	
Automotive repair shops	103.3	104.0	112.3	
Motion picture theaters	110.8	109.8	106.5	

Industry	1995	1996	1997	1998
Mining				
Copper ores	117.2	116.5	118.9	117.5
Gold and silver ores	144.2	138.3	159.0	186.3
Bituminous coal and lignite mining	155.9	168.0	176.6	187.3
Crude petroleum and natural gas	119.4	123.9	125.2	128.7
Crushed and broken stone	105.4	107.2	114.0	111.9
Manufacturing				
Meat products	102.3	97.4	103.2	--
Dairy products	116.4	116.0	119.5	--
Preserved fruits and vegetables	109.1	109.2	111.8	--
Grain mill products	115.4	108.0	118.7	--
Bakery products	97.3	95.6	99.3	--
Sugar and confectionery products	108.3	113.8	117.1	--
Fats and oils	120.3	110.1	120.0	--
Beverages	134.3	135.7	136.3	--
Miscellaneous food and kindred products	103.1	109.2	103.9	--
Cigarettes	142.9	147.2	147.2	--
Broadwoven fabric mills, cotton	134.0	137.3	130.9	--
Broadwoven fabric mills, manmade	145.3	147.6	161.9	--
Narrow fabric mills	118.9	126.3	107.7	--
Knitting mills	138.6	150.5	150.2	--
Textile finishing, except wool	78.5	79.2	94.0	--
Carpets and rugs	96.8	100.2	100.3	--
Yarn and thread mills	137.4	147.4	155.5	--
Miscellaneous textile goods	123.7	123.1	117.9	--
Men's and boys' suits and coats	92.5	97.4	130.3	--
Men's and boys' furnishings	123.4	134.7	152.4	--
Women's and misses' outerwear	135.5	141.6	151.5	--
Women's and children's undergarments	161.3	174.5	196.3	--
Hats, caps, and millinery	84.3	82.2	83.5	--
Miscellaneous apparel and accessories	116.8	120.1	105.2	--
Miscellaneous fabricated textile products	109.2	105.6	117.0	--
Logging	86.0	85.4	71.9	--
Sawmills and planing mills	110.2	115.6	117.5	--

Millwork, plywood, and structural members	92.7	92.4	89.9	--
Wood containers	106.1	106.7	106.6	--
Wood buildings and mobile homes	97.0	96.7	101.1	--
Miscellaneous wood products	115.4	114.4	123.1	--
Household furniture	116.9	121.6	121.8	--
Office furniture	101.1	106.4	117.9	--
Public building and related furniture	173.3	181.5	186.5	--
Partitions and fixtures	101.2	97.5	121.4	--
Miscellaneous furniture and fixtures	110.0	113.2	102.2	--
Pulp mills	131.9	132.6	104.4	--
Paper mills	118.6	111.6	107.0	--
Paperboard mills	119.5	118.0	124.2	--
Paperboard containers and boxes	105.1	106.3	110.1	--
Miscellaneous converted paper products	113.3	113.6	121.7	--
Newspapers	79.0	77.4	79.0	--
Periodicals	87.8	89.1	100.1	--
Books	101.6	99.3	102.2	--
Miscellaneous publishing	94.8	93.6	114.5	--
Commercial printing	107.2	108.3	109.2	--
Manifold business forms	76.9	75.2	78.9	--
Greeting cards	92.5	90.8	92.2	--
Blankbooks and bookbinding	108.7	114.5	115.3	--
Printing trade services	116.7	126.2	124.2	--
Industrial inorganic chemicals	109.3	110.1	116.1	--
Plastics materials and synthetics	128.3	125.3	133.8	--
Drugs	108.7	112.1	112.6	--
Soaps, cleaners, and toilet goods	118.6	120.9	130.4	--
Paints and allied products	118.0	125.6	127.2	--
Industrial organic chemicals	98.6	99.0	112.9	--
Agricultural chemicals	108.5	110.0	120.4	--
Miscellaneous chemical products	107.8	110.1	120.2	--
Petroleum refining	132.3	142.0	149.2	--
Asphalt paving and roofing materials	111.2	113.1	120.8	--
Miscellaneous petroleum and coal products	87.4	87.1	97.2	--
Tires and inner tubes	131.1	138.8	148.5	--
Hose and belting and gaskets and packing	104.6	107.4	112.5	--
Fabricated rubber products, n.e.c.	121.5	121.0	125.4	--
Miscellaneous plastics products, n.e.c.	120.9	124.7	130.1	--
Footwear, except rubber	117.1	126.1	129.5	--
Luggage	90.5	110.6	136.4	--
Handbags and personal leather goods	81.8	83.2	109.7	--
Flat glass	99.6	101.5	107.6	--
Glass and glassware, pressed or blown	115.7	121.4	128.2	--
Products of purchased glass	106.1	122.0	125.3	--

Cement, hydraulic	124.3	128.7	133.1	--
Structural clay products	112.6	119.6	116.1	--
Pottery and related products	109.3	119.3	116.1	--
Concrete, gypsum, and plaster products	104.5	107.3	109.2	--
Miscellaneous nonmetallic mineral products	107.8	110.4	112.7	--
Blast furnace and basic steel products	142.7	155.1	160.9	--
Iron and steel foundries	112.7	116.2	121.7	--
Primary nonferrous metals	111.0	110.8	116.0	--
Nonferrous rolling and drawing	99.2	104.0	112.3	--
Nonferrous foundries (castings)	117.8	122.3	126.4	--
Miscellaneous primary metal products	152.2	149.6	140.9	--
Metal cans and shipping containers	144.2	155.2	160.8	--
Cutlery, handtools, and hardware	111.3	118.2	113.1	--
Plumbing and heating, except electric	109.2	118.6	127.2	--
Fabricated structural metal products	105.8	106.5	110.0	--
Screw machine products, bolts, etc.	109.7	110.2	151.3	--
Metal forgings and stampings	109.3	113.6	120.2	--
Metal services, n.e.c.	127.7	128.4	123.5	--
Ordnance and accessories, n.e.c.	87.6	87.5	100.5	--
Miscellaneous fabricated metal products	106.6	108.3	106.2	--
Engines and turbines	122.7	136.6	134.2	--
Farm and garden machinery	134.7	137.2	141.0	--
Construction and related machinery	122.1	123.6	131.8	--
Metalworking machinery	114.8	114.9	118.6	--
Special industry machinery	132.3	134.0	130.1	--
General industrial machinery	109.0	109.4	110.1	--
Refrigeration and service machinery	112.7	114.7	114.8	--
Industrial machinery, n.e.c.	138.8	141.4	129.7	--
Electric distribution equipment	143.0	143.9	143.9	--
Electrical industrial apparatus	150.8	154.3	163.9	--
Household appliances	127.3	127.4	138.1	--
Electric lighting and wiring equipment	113.7	116.9	121.4	--
Communications equipment	170.9	190.3	221.0	--
Miscellaneous electrical equipment & supplies	114.1	123.1	124.6	--
Motor vehicles and equipment	106.7	107.2	116.5	--
Aircraft and parts	107.8	113.0	114.0	--
Ship and boat building and repairing	98.0	99.2	104.3	--
Railroad equipment	150.0	148.3	183.2	--
Motorcycles, bicycles, and parts	120.3	125.5	120.5	--
Guided missiles, space vehicles, parts	121.0	129.4	126.6	--
Search and navigation equipment	149.5	142.2	148.9	--
Measuring and controlling devices	147.8	151.9	144.3	--

Medical instruments and supplies	131.5	139.8	146.3	--
Ophthalmic goods	167.2	188.2	202.6	--
Photographic equipment & supplies	129.5	128.7	121.6	--
Jewelry, silverware, and plated ware	100.2	102.6	117.2	--
Musical instruments	86.9	78.8	83.9	--
Toys and sporting goods	113.6	119.9	139.6	--
Pens, pencils, office, and art supplies	135.2	144.1	127.7	--
Costume jewelry and notions	143.7	142.2	119.1	--
Miscellaneous manufactures	108.1	112.8	109.3	--
Transportation				
Trucking, except local(1)	125.4	130.9	132.4	130.1
U.S. postal service(2)	106.5	104.7	108.3	109.5
Air transportation(1)	108.6	111.6	111.1	108.5
Utilities				
Telephone communications	148.1	159.5	160.9	171.2
Radio and television broadcasting	109.6	105.8	101.1	100.8
Cable and other pay TV services	86.7	84.4	87.6	88.0
Electric utilities	135.0	150.5	146.5	157.2
Gas utilities	137.1	158.6	145.9	153.4
Trade				
Lumber and other building materials dealers	117.6	121.7	122.2	133.0
Paint, glass, and wallpaper stores	135.3	140.2	143.8	166.0
Hardware stores	108.5	112.1	111.2	125.3
Retail nurseries, lawn and garden supply store	117.2	136.6	128.1	136.1
Department stores	110.9	118.4	123.5	129.4
Variety stores	203.2	229.2	247.6	262.5
Miscellaneous general merchandise stores	163.9	164.9	168.2	189.9
Grocery stores	91.2	89.4	89.2	90.2
Meat and fish (seafood) markets	89.1	81.1	84.7	89.9
Retail bakeries	86.8	81.7	75.4	65.0
New and used car dealers	107.1	108.2	107.8	108.0
Auto and home supply stores	105.7	104.6	104.2	107.0
Gasoline service stations	126.3	125.1	125.0	130.6
Men's and boys' wear stores	117.5	125.7	132.2	145.5
Women's clothing stores	128.5	142.3	145.8	154.8
Family clothing stores	133.8	138.8	142.1	145.6
Shoe stores	134.5	146.9	143.5	136.4
Miscellaneous apparel and accessory stores	122.1	127.1	118.1	131.0
Furniture and homefurnishings stores	112.0	118.6	119.4	121.6
Household appliance stores	138.7	141.8	155.5	184.5
Radio, television, computer, and				

music stores	196.7	204.6	215.1	258.9
Eating and drinking places	100.9	99.5	100.5	101.1
Drug and proprietary stores	106.9	109.6	115.4	117.7
Liquor stores	103.7	112.8	108.9	113.9
Used merchandise stores	117.3	129.8	138.0	158.4
Miscellaneous shopping goods stores	117.8	120.0	123.7	131.5
Nonstore retailers	146.1	165.5	177.2	193.5
Fuel dealers	114.2	115.8	113.4	112.0
Retail stores, n.e.c.	126.2	139.5	147.3	157.6
Finance and services				
Commercial banks	126.4	129.7	133.0	133.0
Hotels and motels	110.1	109.7	107.9	108.8
Laundry, cleaning, and garment services	105.5	108.7	108.0	113.5
Photographic studios, portrait	129.3	126.6	133.7	153.4
Beauty shops	103.5	106.3	107.5	108.4
Barber shops	114.6	127.6	149.0	153.0
Funeral services and crematories	99.7	97.1	101.3	107.0
Automotive repair shops	119.5	114.1	115.2	121.2
Motion picture theaters	101.4	100.5	99.8	101.3

(1) Refers to output per employee.

(2) Refers to output per full-time equivalent employee year on fiscal basis.

n.e.c. = not elsewhere classified

Dash indicates data not available.

43. Unemployment rates, approximating U.S. concepts, in nine countries, quarterly data seasonally adjusted

	Annual average		1998			
	1998	1999	I	II	III	IV
United States	4.5	4.2	4.7	4.4	4.5	4.4
Canada	8.3	7.6	8.6	8.3	8.2	8.1
Australia	8.0	7 2	8.1	8.0	8.1	7.7
Japan	4.1	4.7	3.7	4.2	4.3	4.5
France	11.8	11.1	12.0	11.7	11.7	11.5
Germany	9.4	9.0	9.9	9.5	9.1	9.1
Italy	12.0	11.5	11.8	12.0	12.0	12.0
Sweden	8.4	7.1	8.8	8.7	8.5	7.6
United Kingdom	6.3	6.1	6.4	6.3	6.3	6.3

	1999			
Country	I	II	III	IV
United States	4.3	4.3	4.2	4.1
Canada	7.9	7.8	7.6	7.0
Australia	7.5	7.4	7.1	7.0
Japan	4.7	4.8	4.8	4.7
France	11.3	11.2	11.0	10.6
Germany	9.0	9.0	9.1	9.0
Italy	11.9	11.6	11.6	11.1
Sweden	7.2	7.0	7.0	71.0
United Kingdom	6.3	6.1	5.9	5.9

(1) Quarterly rates are for the first month of the quarter. Dash indicates data not available,

NOTE: Quarterly figures for France, Germany, and the United Kingdom

calculated by applying annual adjustment factors to current published data, and therefore should be viewed as less precise indicators of unemployment under U.S. concepts than the annual figures. See Notes on the data for information on breaks in series. For further qualifications and historical data, see Comparative Civilian Labor Force Statistics, Ten Countries, 1959-1998 (Bureau of Labor Statistics, Oct. 22, 1999).

44. Annual data: Employment status of the working-age population, approximating U.S. concepts, 10 countries

(Numbers in thousands)

Employment status and country	1990	1991	1992
Civilian labor force			
United States(1)	125,840	126,346	128,105
Canada	14,241	14,330	14,362
Australia	8,444	8,490	8,562
Japan	63,050	64,280	65,040
France	24,300	24,490	24,550
Germany(2)	29,410	39,130	39,040
Italy	22,670	22,940	22,910
Netherlands	6,640	6,750	6,950
Sweden	4,597	4,591	4,520
United Kingdom	28,730	28,610	28,410
Participation rate(3)			
United States(1)	66.5	66.2	66.4
Canada	67.1	66.5	65.7
Australia	64.6	64.1	63.9
Japan	62.6	63.2	63.4
France	58.0	56.0	55.8
Germany(2)	55.3	58.9	58.3
Italy	47.2	47.7	47.5
Netherlands	56.1	56.5	57.8
Sweden	67.4	67.0	65.7
United Kingdom	64.1	63.7	63.1
Employed			
United States(1)	118,793	117,718	118,492
Canada	13,084	12,851	12,760
Australia	7,859	7,676	7,637
Japan	61,710	62,920	63,620
France	22,100	22,140	21,990
Germany(2)	27,950	36,920	36,420
Italy	21,080	21,360	21,230
Netherlands	6,230	6,350	6,560
Sweden	4,513	4,447	4,265
United Kingdom	26,740	26,090	25,530
Employment-population ratio(4)			
United States(1)	62.8	81.7	61.5
Canada	61.7	59.7	58.4
Australia	60.1	57.9	57.0
Japan	61.3	61.8	62.0
France	50.9	50.6	49.9
Germany(2)	52.6	55.5	54.4
Italy	43.9	44.5	44.0
Netherlands	52.6	53.2	54.5
Sweden	66.1	64.9	62.0
United Kingdom	59.6	58.0	56.7

Unemployed			
United States(1)	7,047	8,628	9,613
Canada	1,157	1,480	1,602
Australia	585	814	925
Japan	1,340	1,360	1,420
France	2,210	2,350	2,560
Germany(2)	1,460	2,210	2,620
Italy	1,590	1,580	1,680
Netherlands	410	400	390
Sweden	64	144	255
United Kingdom	1,990	2,520	2,880
Unemployment rate			
United States(1)	5.6	6.8	7.5
Canada	8.1	10.3	11.2
Australia	6.9	9.6	10.8
Japan	2.1	2.1	2.2
France	9.1	9.6	10.4
Germany(2)	5.0	5.6	6.7
Italy	7.0	6.9	7.3
Netherlands	6.2	5.9	5.6
Sweden	1.8	3.1	5.6
United Kingdom	6.9	8.8	10.1

Employment status and country	1993	1994	1995
Civilian labor force			
United States(1)	129,200	131,056	132,304
Canada	14,505	14,627	14,750
Australia	8,619	8,776	9,001
Japan	65,470	85,780	65,990
France	24,650	24,760	24,820
Germany(2)	39,140	39,210	39,100
Italy	22,570	22,450	22,460
Netherlands	7,090	7,190	7,270
Sweden	4,443	4,418	4,460
United Kingdom	28,310	28,280	28,480
Participation rate(3)			
	66.3	66.6	66.6
United States(1)			
Canada	65.4	65.2	64.9
Australia	63.6	63.9	64.8
Japan	63.3	63.1	62.9
France	55.6	55.5	55.2
Germany(2)	58.0	57.6	57.3
Italy	47.9	47.3	47.1
Netherlands	58.5	59.0	59.3
Sweden	64.5	63.7	64.1
United Kingdom	62.8	62.5	62.7
Employed			
United States(1)	120,259	123,060	124,900
Canada	12,858	13,112	13,357
Australia	7,680	7,921	8,235
Japan	63,810	63,860	63,890
France	21,740	21,710	21,890

Germany(2)	36,030	35,890	35,900
Italy	20,270	19,940	19,820
Netherlands	6,620	6,670	6,760
Sweden	4,028	3,992	4,056
United Kingdom	25,340	25,550	26,000
Employment-population ratio(4)			
United States(1)	61.7	62.5	62.9
Canada	58.0	58.4	58.8
Australia	56.6	57.7	59.1
Japan	61.7	61.3	60.9
France	49.0	48.7	48.7
Germany(2)	53.4	52.8	52.6
Italy	43.0	42.0	41.5
Netherlands	54.7	54.7	55.1
Sweden	58.5	57.6	58.3
United Kingdom	56.2	56.5	57.2
Unemployed			
United States(1)	8,940	7,996	7,404
Canada	1,647	1,515	1,393
Australia	939	856	766
Japan	1,660	1,920	2,100
France	2,910	3,050	2,920
Germany(2)	3,110	3,320	3,200
Italy	2,300	2,510	2,640
Netherlands	470	520	510
Sweden	415	426	404
United Kingdom	2,970	2,730	2,480
Unemployment rate			
United States(1)	6.9	6.1	5.6
Canada	11.4	10.4	9.4
Australia	10.9	9.7	8.5
Japan	2.5	2.9	3.2
France	11.8	12.3	11.8
Germany(2)	7.9	8.5	8.2
Italy	10.2	11.2	11.8
Netherlands	6.6	7.2	7.0
Sweden	9.3	9.6	9.1
United Kingdom	10.5	9.7	8.7

Employment status and country	1996	1997
Civilian labor force		
United States(1)	133,943	136,297
Canada	14,900	15,153
Australia	9,127	9,221
Japan	66,450	67,200
France	25,090	25,180
Germany(2)	39,180	39,450
Italy	22,570	22,680
Netherlands	7,370	7,530
Sweden	4,459	4,418
United Kingdom	28,620	28,760
Participation rate(3)		
	66.8	67.1

United States(1)		
Canada	64.7	64.9
Australia	84.6	64.3
Japan	63.0	63.2
France	55.5	55.3
Germany(2)	57.4	57.6
Italy	47.1	47.2
Netherlands	59.8	60.7
Sweden	64.0	63.3
United Kingdom	62.7	62.8

Employed

United States(1)	126,708	129,558
Canada	13,463	13,774
Australia	8,344	8,429
Japan	64,200	64,900
France	21,960	22,060
Germany(2)	35,680	35,540
Italy	19,920	19,990
Netherlands	6,900	7,130
Sweden	4,019	3,973
United Kingdom	28,280	28,740

Employment-population ratio(4)

United States(1)	63.2	63.8
Canada	58.5	59.0
Australia	59.1	58.8
Japan	60.9	61.0
France	48.5	48.4
Germany(2)	52.2	51.9
Italy	41.6	41.6
Netherlands	55.9	57.5
Sweden	57.7	56.9
United Kingdom	57.6	58.3

Unemployed

United States(1)	7,236	6,739
Canada	1,437	1,379
Australia	783	791
Japan	2,250	2,300
France	3,130	3,120
Germany(2)	3,500	3,910
Italy	2,650	2,690
Netherlands	470	400
Sweden	440	445
United Kingdom	2,340	2,020

Unemployment rate

United States(1)	5.4	4.9
Canada	9.6	9.1
Australia	8.6	8.6
Japan	3.4	3.4
France	12.5	12.4
Germany(2)	8.9	9.9
Italy	11.7	11.9
Netherlands	6.4	5.3
Sweden	9.9	10.1
United Kingdom	8.2	7.0

Employment status and country	1998	1999
Civilian labor force		
United States(1)	137,673	139,368
Canada	15,418	15,721
Australia	9,347	9,470
Japan	67,240	67,100
France	25,360	25,590
Germany(2)	39,430	--
Italy	22,960	23,130
Netherlands	7,720	--
Sweden	4,402	4,430
United Kingdom	28,870	29,090
Participation rate(3)		
United States(1)	67.1	67.1
Canada	65.1	65.6
Australia	64.4	64.2
Japan	62.8	62.4
France	55.4	55.7
Germany(2)	57.6	--
Italy	47.6	47.8
Netherlands	62.0	--
Sweden	62.8	63.2
United Kingdom	62.7	62.9
Employed		
United States(1)	131,463	133,488
Canada	14,140	14,531
Australia	8,597	8,785
Japan	64,450	63,930
France	22,390	22,760
Germany(2)	35,720	--
Italy	20,210	20,460
Netherlands	7,410	--
Sweden	4,034	4,117
United Kingdom	27,050	27,330
Employment-population ratio(4)		
United States(1)	64.1	64.3
Canada	59.7	60.6
Australia	59.2	59.6
Japan	60.2	59.4
France	48.9	49.6
Germany(2)	52.2	--
Italy	41.9	42.3
Netherlands	59.5	--
Sweden	57.6	58.7
United Kingdom	58.7	59.1
Unemployed		
United States(1)	6,210	6,210
Canada	1,277	1,190
Australia	750	685
Japan	2,790	3,170
France	2,980	2,830

Germany(2)	3,710	--
Italy	2,750	2,670
Netherlands	310	--
Sweden	368	313
United Kingdom	1,820	1,760
Unemployment rate		
United States(1)	4.5	4.2
Canada	8.3	7.6
Australia	8.0	7.2
Japan	4.1	4.7
France	11.8	11.1
Germany(2)	9.4	9.0
Italy	12.0	11.5
Netherlands	4.0	--
Sweden	8.4	7.1
United Kingdom	6.3	6.1

(1) Data for 1994 are not directly comparable with data for 1993 and earlier years. For additional information, see the box note under "Employment and Unemployment Data" in the notes to this section.

(2) Data from 1991 onward refer to unified Germany. See Comparative Civilian Labor Force Statistics, Ten Countries, 1959-1998, October 22, 1999, on the Internet at http://stats.bls.gov/flsdata.htm.

(3) Labor force as a percent of the working-age population.

(4) Employment as a percent of the working-age population.

NOTE: See "Notes on the data" for information on breaks in series for the United States, France, Germany, Italy, the Netherlands, and Sweden. Dash indicates data not available.

45. Annual indexes of manufacturing productivity and related measures, 12 countries

(1992 = 100)

Item and country	1960	1970	1980
Output per hour			
United States	--	--	71.9
Canada	40.7	59.2	75.3
Japan	14.0	38.0	63.9
Belgium	18.0	32.9	65.4
Denmark	29.9	52.7	90.3
France	21.8	43.1	66.7
Germany	29.2	52.0	77.2
Italy	19.6	36.8	64.1
Netherlands	18.6	38.1	69.2
Norway	36.7	57.8	76.7
Sweden	27.6	52.8	74.0
United Kingdom	31.2	44.7	56.1
Output			
United States	--	--	77.3
Canada	34.2	60.5	85.4
Japan	10.7	38.8	59.9
Belgium	30.7	57.6	78.2
Denmark	40.8	68.0	91.3
France	31.0	64.1	88.7
Germany	41.5	70.9	85.3
Italy	21.4	44.7	78.4
Netherlands	31.7	59.5	77.4
Norway	56.5	89.1	103.6
Sweden	46.5	81.7	91.8

United Kingdom	67.7	90.3	87.2
Total hours			
United States	92.1	104.4	107.5
Canada	84.1	102.1	113.5
Japan	76.3	102.3	93.8
Belgium	170.7	174.7	119.7
Denmark	136.5	129.0	101.1
France	142.1	148.7	133.1
Germany	142.3	136.3	110.5
Italy	109.0	121.2	122.4
Netherlands	170.6	156.2	111.8
Norway	154.0	154.3	135.0
Sweden	168.3	154.7	124.0
United Kingdom	217.3	202.1	155.3
Compensation per hour			
United States	14.9	23.7	55.6
Canada	10.4	17.8	47.7
Japan	4.3	16.5	58.6
Belgium	5.4	13.7	52.5
Denmark	4.6	13.3	49.6
France	4.3	10.3	40.8
Germany	8.1	20.7	53.6
Italy	1.6	4.7	28.2
Netherlands	6.4	20.2	64.4
Norway	4.7	11.8	39.0
Sweden	4.1	10.8	37.4
United Kingdom	3.1	6.3	33.2
Unit labor coasts: National currency basis			
United States	--	--	77.2
Canada	25.5	30.0	63.3
Japan	30.9	43.3	91.7
Belgium	30.1	41.7	80.3
Denmark	15.4	25.2	55.0
France	19.5	24.0	61.2
Germany	27.8	39.8	69.4
Italy	8.0	12.7	44.0
Netherlands	34.4	52.9	93.0
Norway	12.9	20.4	50.8
Sweden	14.9	20.5	50.6
United Kingdom	9.8	14.1	59.1
Unit labor costs: U.S. dollar basis			
United States	--	--	77.2
Canada	31.8	34.7	65.4
Japan	10.9	15.3	51.3
Belgium	19.4	27.0	88.3
Denmark	13.5	20.3	58.9
France	21.1	23.0	76.7
Germany	10.4	17.1	59.6
Italy	16.0	24.9	63.3
Netherlands	16.0	25.7	82.3
Norway	11.3	17.8	63.9
Sweden	16.8	23.0	69.6
United Kingdom	15.6	19.2	77.8

Item and country	1987	1988	1989
Output per hour			
United States	94.4	98.0	97.1
Canada	91.3	91.1	92.4
Japan	81.2	84.8	89.5
Belgium	88.9	92.0	96.9
Denmark	90.6	94.1	99.6
France	81.8	87.4	91.9
Germany	88.1	91.5	94.6
Italy	85.1	86.7	89.4
Netherlands	91.6	93.7	97.1
Norway	93.3	92.1	94.6
Sweden	90.1	90.8	93.8
United Kingdom	79.4	82.3	86.2
Output			
United States	97.9	104.5	104.0
Canada	103.2	109.3	110.8
Japan	78.4	84.6	90.2
Belgium	88.8	93.3	99.1
Denmark	99.3	100.8	104.3
France	87.2	92.2	97.2
Germany	88.0	90.9	94.0
Italy	88.2	94.5	98.1
Netherlands	89.5	92.8	96.9
Norway	110.7	105.3	101.3
Sweden	107.7	110.2	111.6
United Kingdom	94.4	101.4	105.4
Total hours			
United States	103.8	106.6	107.1
Canada	113.0	120.0	119.9
Japan	96.6	99.8	100.8
Belgium	100.0	101.5	102.3
Denmark	109.6	107.2	104.7
France	106.6	105.5	105.8
Germany	99.9	99.3	99.3
Italy	103.6	108.9	109.7
Netherlands	97.7	99.0	99.8
Norway	118.6	114.3	107.1
Sweden	119.5	121.4	119.0
United Kingdom	118.9	123.2	122.3
Compensation per hour			
United States	80.7	84.0	86.6
Canada	75.3	77.8	82.5
Japan	77.9	79.2	84.2
Belgium	79.7	81.1	85.9
Denmark	80.1	82.9	87.7
France	78.6	81.6	86.0
Germany	76.0	79.1	83.2
Italy	66.7	69.3	75.9
Netherlands	87.8	87.7	88.5
Norway	78.5	83.3	87.2
Sweden	67.3	71.7	79.4
United Kingdom	64.8	67.7	72.9

Unit labor coasts: National currency basis			
United States	85.5	85.7	89.2
Canada	82.5	85.5	89.2
Japan	96.0	93.4	94.0
Belgium	89.7	88.1	88.7
Denmark	88.4	88.2	88.1
France	96.2	93.4	93.6
Germany	86.3	86.5	87.9
Italy	78.3	79.9	84.9
Netherlands	95.9	93.6	91.1
Norway	84.1	90.4	92.2
Sweden	74.7	79.0	84.7
United Kingdom	81.6	82.2	84.6
Unit labor costs: U.S. dollar basis			
United States	85.5	85.7	89.2
Canada	75.2	83.9	91.0
Japan	84.2	92.4	86.3
Belgium	77.2	77.0	72.3
Denmark	77.9	79.0	72.6
France	84.7	82.9	77.7
Germany	74.9	76.9	73.0
Italy	74.4	75.6	76.2
Netherlands	83.2	83.2	75.5
Norway	77.5	86.1	82.9
Sweden	68.5	75.0	76.4
United Kingdom	75.7	82.9	78.5

Item and country	1990	1991	1993
Output per hour			
United States	97.8	98.3	102.1
Canada	95.3	95.1	102.5
Japan	95.4	99.4	100.5
Belgium	96.8	99.1	102.5
Denmark	99.1	99.6	104.5
France	93.5	96.9	100.6
Germany	99.0	101.9	100.6
Italy	92.5	95.2	102.9
Netherlands	98.6	99.6	101.4
Norway	96.6	97.5	100.6
Sweden	95.0	95.0	106.7
United Kingdom	88.3	92.2	104.0
Output			
United States	102.5	98.7	103.5
Canada	106.6	98.8	105.1
Japan	96.3	101.4	96.0
Belgium	101.0	100.7	97.0
Denmark	102.7	101.7	99.0
France	99.1	99.8	95.7
Germany	99.1	102.8	91.8
Italy	99.6	99.2	96.4
Netherlands	100.1	100.6	98.2
Norway	100.2	98.3	102.7
Sweden	110.6	103.6	101.3
United Kingdom	105.3	100.0	101.4

Item and country	1994	1995	1996
Total hours			
United States	104.8	100.4	101.4
Canada	111.9	103.8	102.6
Japan	100.9	102.0	95.6
Belgium	104.3	101.5	94.7
Denmark	103.7	102.1	94.8
France	105.9	103.0	95.1
Germany	100.1	100.9	91.3
Italy	107.7	104.2	93.6
Netherlands	101.5	101.0	96.9
Norway	103.7	100.8	102.1
Sweden	116.4	109.0	94.9
United Kingdom	119.2	108.5	97.5
Compensation per hour			
United States	90.8	95.6	102.7
Canada	89.5	94.7	99.6
Japan	90.7	95.9	104.6
Belgium	90.1	97.3	104.8
Denmark	92.7	95.9	104.6
France	90.6	96.2	102.8
Germany	89.4	95.1	105.9
Italy	84.4	93.6	107.5
Netherlands	90.8	95.2	103.7
Norway	92.3	97.5	101.5
Sweden	87.6	95.4	98.0
United Kingdom	80.9	90.5	104.3
Unit labor coasts: National currency basis			
United States	92.8	97.2	100.6
Canada	93.9	99.6	97.2
Japan	95.0	96.5	104.1
Belgium	93.0	98.1	102.3
Denmark	93.6	96.3	100.1
France	96.8	99.3	102.2
Germany	90.3	93.3	105.3
Italy	91.3	98.4	104.4
Netherlands	92.1	95.5	102.3
Norway	95.6	100.0	100.9
Sweden	92.3	100.4	91.8
United Kingdom	91.6	98.2	100.3
Unit labor costs: U.S. dollar basis			
United States	92.8	97.2	100.6
Canada	97.2	105.0	91.1
Japan	83.1	90.9	118.8
Belgium	89.5	92.3	95.1
Denmark	91.3	90.8	93.2
France	94.1	93.1	95.5
Germany	87.3	87.8	99.4
Italy	93.8	97.6	81.8
Netherlands	88.9	89.8	96.8
Norway	95.0	95.7	88.3
Sweden	90.8	96.6	68.6
United Kingdom	92.5	98.2	85.3

Output per hour

United States	108.3	114.9	117.3
Canada	106.2	108.9	107.3
Japan	101.8	109.3	115.8
Belgium	108.4	113.2	114.7
Denmark	--	--	--
France	108.5	114.4	114.9
Germany	107.9	111.2	115.1
Italy	105.6	109.3	110.3
Netherlands	112.7	117.7	119.7
Norway	101.4	102.0	102.0
Sweden	116.1	122.4	125.4
United Kingdom	106.8	104.8	103.2

Output

United States	112.2	119.6	121.6
Canada	113.2	118.8	120.2
Japan	95.4	100.6	106.7
Belgium	101.4	104.2	104.2
Denmark	109.3	114.7	117.8
France	100.3	104.8	104.5
Germany	93.5	93.7	92.5
Italy	102.2	107.2	106.7
Netherlands	104.2	107.8	108.4
Norway	106.7	109.0	110.1
Sweden	115.7	130.1	132.9
United Kingdom	106.1	107.8	108.2

Total hours

United States	103.6	104.0	103.7
Canada	106.6	109.1	112.0
Japan	93.7	92.0	92.2
Belgium	93.6	92.0	90.8
Denmark	--	--	--
France	92.4	91.6	91.0
Germany	86.7	84.3	80.4
Italy	96.7	98.0	96.7
Netherlands	92.4	91.6	90.5
Norway	105.2	106.9	107.9
Sweden	99.6	106.3	106.0
United Kingdom	99.4	102.9	104.8

Compensation per hour

United States	105.6	107.9	109.3
Canada	100.4	103.6	102.8
Japan	106.7	109.5	110.9
Belgium	106.1	109.2	112.0
Denmark	--	--	--
France	105.0	107.6	109.5
Germany	111.7	117.7	123.7
Italy	107.8	112.8	120.9
Netherlands	108.2	110.6	113.2
Norway	104.4	109.2	113.6
Sweden	101.1	106.2	113.4
United Kingdom	106.5	107.4	108.2

Unit labor coasts: National currency basis

United States	97.6	93.9	93.2
Canada	94.5	95.2	95.8
Japan	104.9	100.1	95.8
Belgium	97.9	96.4	97.6
Denmark	93.0	93.8	92.7
France	96.8	94.1	95.3
Germany	103.6	105.9	107.5
Italy	102.1	103.2	109.6
Netherlands	96.0	94.0	94.6
Norway	102.9	107.1	111.4
Sweden	87.0	86.8	90.4
United Kingdom	99.7	102.5	104.8
Unit labor costs: U.S. dollar basis			
United States	97.6	93.9	93.2
Canada	83.6	83.8	84.9
Japan	130.1	135.1	111.7
Belgium	94.2	105.2	101.4
Denmark	88.3	101.1	96.5
France	92.4	99.9	98.6
Germany	99.8	115.5	111.6
Italy	78.1	78.0	87.5
Netherlands	92.8	103.0	96.8
Norway	90.7	105.0	107.1
Sweden	65.7	70.8	78.5
United Kingdom	86.5	91.6	95.6

Item and country	1997	1998
Output per hour		
United States	122.1	127.9
Canada	111.0	111.7
Japan	121.4	120.4
Belgium	121.8	122.6
Denmark	--	--
France	123.2	127.4
Germany	121.8	127.1
Italy	113.4	113.6
Netherlands	125.7	127.8
Norway	101.9	104.1
Sweden	133.6	136.5
United Kingdom	104.0	105.1
Output		
United States	128.8	135.0
Canada	128.0	133.0
Japan	111.1	103.6
Belgium	109.0	111.8
Denmark	120.3	126.5
France	110.2	114.6
Germany	95.8	100.7
Italy	110.4	112.5
Netherlands	114.1	116.6
Norway	113.3	116.4
Sweden	140.3	146.4
United Kingdom	109.6	110.0
Total hours		

United States	105.5	105.6
Canada	115.4	119.0
Japan	91.5	86.1
Belgium	89.5	91.2
Denmark	--	--
France	89.5	89.9
Germany	78.6	79.3
Italy	97.4	99.0
Netherlands	90.8	91.2
Norway	111.1	111.9
Sweden	105.0	107.3
United Kingdom	105.4	104.7
Compensation per hour		
United States	113.4	119.4
Canada	106.7	110.8
Japan	113.9	115.8
Belgium	115.2	116.0
Denmark	--	--
France	112.3	113.9
Germany	126.6	127.6
Italy	125.9	124.8
Netherlands	115.8	118.3
Norway	119.1	126.4
Sweden	118.3	121.5
United Kingdom	111.4	117.8
Unit labor coasts: National currency basis		
United States	92.9	93.4
Canada	96.2	99.2
Japan	93.8	96.2
Belgium	94.6	94.7
Denmark	95.9	94.0
France	91.2	89.4
Germany	103.9	100.4
Italy	111.1	109.8
Netherlands	92.2	92.5
Norway	116.9	121.4
Sweden	88.5	89.0
United Kingdom	107.1	112.1
Unit labor costs: U.S. dollar basis		
United States	92.9	93.4
Canada	83.9	80.8
Japan	98.3	93.1
Belgium	84.9	83.8
Denmark	87.6	84.7
France	82.6	80.2
Germany	93.5	89.1
Italy	80.3	77.9
Netherlands	83.0	82.0
Norway	102.5	99.9
Sweden	67.5	65.2
United Kingdom	99.3	105.2

-- Data not available.

46. Occupational injury and illness rates by industry,(1) United States

Incidence rates per 100 full-time

Industry and type of case(2)	1987	1988	1989(1)
	workers(3)		
PRIVATE SECTOR(5)			
Total cases	8.3	8.6	8.6
Lost workday cases	3.8	4.0	4.0
Lost workdays	89.9	78.1	78.7
Agriculture, forestry, and fishing(6)			
Total cases	11.2	10.9	10.9
Lost workday cases	5.7	5.6	5.7
Lost workdays	94.1	101.8	100.9
Mining			
Total cases	8.5	8.8	8.5
Lost workday cases	4.9	5.1	4.8
Lost workdays	144.0	152.1	137.2
Construction			
Total cases	14.7	14.6	14.3
Lost workday cases	6.8	6.8	6.8
Lost workdays	135.8	142.2	143.3
General building contractors:			
Total cases	14.2	14.0	13.9
Lost workday cases	6.5	6.4	6.5
Lost workdays	134.0	132.2	137.3
Heavy construction, except building:			
Total cases	14.5	15.1	13.8
Lost workday cases	6.4	7.0	6.5
Lost workdays	139.1	182.3	147.1
Special trades contractors:			
Total cases	15.0	14.7	14.6
Lost workday cases	7.1	7.0	6.9
Lost workdays	135.7	141.1	144.9
Manufacturing			
Total cases	11.9	13.1	13.1
Lost workday cases	5.3	5.7	5.8
Lost workdays	95.5	107.4	113.0
Durable goods:			
Total cases	12.5	14.2	14.1
Lost workday cases	5.4	5.9	6.0
Lost workdays	96.8	111.1	116.5
Lumber and wood products:			
Total cases	18.9	19.5	18.4
Lost workday cases	9.6	10.0	9.4
Lost workdays	176.5	189.1	177.5
Furniture and fixtures:			
Total cases	15.4	16.6	16.1
Lost workday cases	6.7	7.3	7.2
Lost workdays	103.6	115.7	--
Stone clay and glass products:			
Total cases	14.9	16.0	15.5
Lost workday cases	7.1	7.5	7.4
Lost workdays	135.8	141.0	149.8

Primary metal industries:			
Total cases	17.0	19.4	18.7
Lost workday cases	7.4	8.2	8.1
Lost workdays	145.8	161.3	168.3
Fabricated metal products:			
Total cases	17.0	18.8	18.5
Lost workday cases	7.2	8.0	7.9
Lost workdays	121.9	138.8	147.6
Industrial machinery and equipment:			
Total cases	11.3	12.1	12.1
Lost workday cases	4.4	4.7	4.8
Lost workdays	72.7	82.8	86.8
Electronic and other electrical equipment:			
Total cases	7.2	8.0	9.1
Lost workday cases	3.1	3.3	3.9
Lost workdays	55.9	64.6	77.5
Transportation equipment:			
Total cases	13.5	17.7	17.7
Lost workday cases	5.7	6.6	6.8
Lost workdays	105.7	134.2	138.6
Instruments and related products:			
Total cases	5.8	6.1	5.6
Lost workday cases	2.4	2.6	2.5
Lost workdays	43.9	51.5	55.4
Miscellaneous manufacturing industries:			
Total cases	10.7	11.3	11.1
Lost workday cases	4.6	5.1	5.1
Lost workdays	81.5	91.0	97.6
Nondurable goods:			
Total cases	11.1	11.4	11.6
Lost workday cases	5.1	5.4	5.5
Lost workdays	93.5	101.7	107.8
Food and kindred products:			
Total cases	17.7	18.5	18.5
Lost workday cases	8.6	9.2	9.3
Lost workdays	153.7	169.7	174.7
Tobacco products:			
Total cases	8.6	9.3	8.7
Lost workday cases	2.5	2.9	3.4
Lost workdays	46.4	53.0	64.2
Textile mill products:			
Total cases	9.0	9.6	10.3
Lost workday cases	3.6	4.0	4.2
Lost workdays	65.9	78.8	81.4
Apparel and other textile products:			
Total cases	7.4	8.1	8.6
Lost workday cases	3.1	3.5	3.8
Lost workdays	59.5	68.2	80.5
Paper and allied products:			
Total cases	12.8	13.1	12.7
Lost workday cases	5.8	5.9	5.8
Lost workdays	122.3	124.3	132.9
Printing and publishing:			
Total cases	6.7	6.6	6.9
Lost workday cases	3.1	3.2	3.3
Lost workdays	55.1	59.8	63.8
Chemicals and allied products:			
Total cases	7.0	7.0	7.0
Lost workday cases	3.1	3.3	3.2
Lost workdays	58.8	59.0	63.4

Petroleum and coal products:			
Total cases	7.3	7.0	6.6
Lost workday cases	3.1	3.2	3.3
Lost workdays	65.9	68.4	68.1
Rubber and miscellaneous plastics products:			
Total cases	15.9	16.3	16.2
Lost workday cases	7.6	8.1	8.0
Lost workdays	130.8	142.9	147.2
Leather and leather products:			
Total cases	12.4	11.4	13.6
Lost workday cases	5.8	5.6	6.5
Lost workdays	114.5	128.2	130.4
Transportation and public utilities			
Total cases	8.4	8.9	9.2
Lost workday cases	4.9	5.1	5.3
Lost workdays	108.1	118.6	121.5
Wholesale and retail trade			
Total cases	7.7	7.8	8.0
Lost workday cases	3.4	3.5	3.6
Lost workdays	56.1	60.9	63.5
Wholesale trade:			
Total cases	7.4	7.6	7.7
Lost workday cases	3.7	3.8	4.0
Lost workdays	64.0	69.2	71.9
Retail trade:			
Total cases	7.8	7.9	8.1
Lost workday cases	3.3	3.4	3.4
Lost workdays	52.9	57.6	60.0
Finance, insurance, and real estate			
Total cases	2.0	2.0	2.0
Lost workday cases	.9	.9	.9
Lost workdays	14.3	17.2	17.6
Services			
Total cases	5.5	5.4	5.5
Lost workday cases	2.7	2.6	2.7
Lost workdays	45.8	47.7	51.2

Industry and type of case(2)	Incidence rates per 100 full-time workers(3)		
	1990	1991	1992
PRIVATE SECTOR(5)			
Total cases	8.8	8.4	8.9
Lost workday cases	4.1	3.9	3.9
Lost workdays	84.0	86.5	93.8
Agriculture, forestry, and fishing(6)			

Total cases	11.6	10.8	11.6
Lost workday cases	5.9	5.4	5.4
Lost workdays	112.2	108.3	126.9
Mining			
Total cases	8.3	7.4	7.3
Lost workday cases	5.0	4.5	4.1
Lost workdays	119.5	129.6	204.7
Construction			
Total cases	14.2	13.0	13.1
Lost workday cases	6.7	6.1	5.8
Lost workdays	147.9	148.1	161.9
General building contractors:			
Total cases	13.4	12.0	12.2
Lost workday cases	6.4	5.5	5.4
Lost workdays	137.6	132.0	142.7
Heavy construction, except building:			
Total cases	13.8	12.8	12.1
Lost workday cases	6.3	6.0	5.4
Lost workdays	144.6	160.1	165.8
Special trades contractors:			
Total cases	14.7	13.5	13.8
Lost workday cases	6.9	6.3	6.1
Lost workdays	153.1	151.3	168.3
Manufacturing			
Total cases	13.2	12.7	12.5
Lost workday cases	5.8	5.6	5.4
Lost workdays	120.7	121.5	124.6
Durable goods:			
Total cases	14.2	13.6	13.4
Lost workday cases	6.0	5.7	5.5
Lost workdays	123.3	122.9	126.7
Lumber and wood products:			
Total cases	18.1	16.8	16.3
Lost workday cases	8.8	8.3	7.6
Lost workdays	172.5	172.0	165.8
Furniture and fixtures:			
Total cases	16.9	15.9	14.8
Lost workday cases	7.8	7.2	6.6
Lost workdays	--	--	128.4
Stone clay and glass products:			
Total cases	15.4	14.8	13.6
Lost workday cases	7.3	6.8	6.1
Lost workdays	160.5	156.0	152.2
Primary metal industries:			
Total cases	19.0	17.7	17.5
Lost workday cases	8.1	7.4	7.1
Lost workdays	180.2	169.1	175.5
Fabricated metal products:			
Total cases	18.7	17.4	16.8
Lost workday cases	7.9	7.1	6.6
Lost workdays	155.7	146.6	144.0
Industrial machinery and equipment:			
Total cases	12.0	11.2	11.1
Lost workday cases	4.7	4.4	4.2
Lost workdays	88.9	86.6	87.7

Electronic and other electrical equipment:			
Total cases	9.1	8.6	8.4
Lost workday cases	3.8	3.7	3.6
Lost workdays	79.4	83.0	81.2
Transportation equipment:			
Total cases	17.8	18.3	18.7
Lost workday cases	6.9	7.0	7.1
Lost workdays	153.7	166.1	186.6
Instruments and related products:			
Total cases	5.9	6.0	5.9
Lost workday cases	2.7	2.7	2.7
Lost workdays	57.8	64.4	65.3
Miscellaneous manufacturing industries:			
Total cases	11.3	11.3	10.7
Lost workday cases	5.1	5.1	5.0
Lost workdays	113.1	104.0	108.2
Nondurable goods:			
Total cases	11.7	11.5	11.3
Lost workday cases	5.6	5.5	5.3
Lost workdays	116.9	119.7	121.8
Food and kindred products:			
Total cases	20.0	19.5	18.8
Lost workday cases	9.9	9.9	9.5
Lost workdays	202.6	207.2	211.9
Tobacco products:			
Total cases	7.7	6.4	6.0
Lost workday cases	3.2	2.8	2.4
Lost workdays	62.3	52.0	42.9
Textile mill products:			
Total cases	9.6	10.1	9.9
Lost workday cases	4.0	4.4	4.2
Lost workdays	85.1	88.3	87.1
Apparel and other textile products:			
Total cases	8.8	9.2	9.5
Lost workday cases	3.9	4.2	4.0
Lost workdays	92.1	99.9	104.6
Paper and allied products:			
Total cases	12.1	11.2	11.0
Lost workday cases	5.5	5.0	5.0
Lost workdays	124.8	122.7	125.9
Printing and publishing:			
Total cases	6.9	6.7	7 3
Lost workday cases	3.3	3.2	3.2
Lost workdays	69.8	74.5	74.8
Chemicals and allied products:			
Total cases	6.5	6.4i	6.0
Lost workday cases	3.1	3.1	2.8
Lost workdays	61.6	62.4	64.2
Petroleum and coal products:			
Total cases	6.6	6.2	5.9
Lost workday cases	3.1	2.9	2.8
Lost workdays	77.3	68.2	71.2
Rubber and miscellaneous plastics products:			
Total cases	16.2	15.1	14.5
Lost workday cases	7.8	7.2	6.8
Lost workdays	151.3	150.9	153.3
Leather and leather products:			
Total cases	12.1	12.5	12.1
Lost workday cases	5.9	5.9	5.4

Lost workdays	152.3	140.8	128.5
Transportation and public utilities			
Total cases	9.6	9.3	9.1
Lost workday cases	5.5	5.4	5.1
Lost workdays	134.1	140.0	144.0
Wholesale and retail trade			
Total cases	7.9	7.6	8.4
Lost workday cases	3.5	3.4	3.5
Lost workdays	65.6	72.0	80.1
Wholesale trade:			
Total cases	7.4	7.2	7.6
Lost workday cases	3.7	3.7	3.6
Lost workdays	71.5	79.2	82.4
Retail trade:			
Total cases	8.1	7.7	8.7
Lost workday cases	3.4	3.3	3.4
Lost workdays	63.2	89.1	79.2
Finance, insurance, and real estate			
Total cases	2.4	2.4	2.9
Lost workday cases	1.1	1.1	1.2
Lost workdays	27.3	24.1	32.9
Services			
Total cases	6.0	6.2	7.1
Lost workday cases	2.8	2.8	3.0
Lost workdays	56.4	60.0	68.6

Industry and type of case(2)	Incidence rates per 100 full-time workers(3) 1993(4)	1994(4)	1995(4)
PRIVATE SECTOR(5)			
Total cases	8.5	8.4	8.1
Lost workday cases	3.8	3.8	3.6
Lost workdays	--	--	--
Agriculture, forestry, and fishing(6)			
Total cases	11.2	10.0	9.7
Lost workday cases	5.0	4.7	4.3
Lost workdays	--	--	--
Mining			
Total cases	6.8	6.3	6.2
Lost workday cases	3.9	3.9	3.9
Lost workdays	--	--	--
Construction			

Total cases	12.2	11.8	10.6
Lost workday cases	5.5	5.5	4.9
Lost workdays	--	--	--
General building contractors:			
Total cases	11.5	10.9	9.8
Lost workday cases	5.1	5.1	4.4
Lost workdays	--	--	--
Heavy construction, except building:			
Total cases	11.1	10.2	9.9
Lost workday cases	5.1	5.0	4.8
Lost workdays	--	--	--
Special trades contractors:			
Total cases	12.8	12.5	11.1
Lost workday cases	5.8	5.8	5.0
Lost workdays	--	--	--
Manufacturing			
Total cases	12.1	12.2	11.6
Lost workday cases	5.3	5.5	5.3
Lost workdays	--	--	--
Durable goods:			
Total cases	13.1	13.5	12.8
Lost workday cases	5.4	5.7	5.6
Lost workdays	--	--	--
Lumber and wood products:			
Total cases	15.9	15.7	14.9
Lost workday cases	7.6	7.7	7.0
Lost workdays	--	--	--
Furniture and fixtures:			
Total cases	14.6	15.0	13.9
Lost workday cases	6.5	7.0	6.4
Lost workdays	--	--	--
Stone clay and glass products:			
Total cases	13.8	13.2	12.3
Lost workday cases	6.3	6.5	5.7
Lost workdays	--	--	--
Primary metal industries:			
Total cases	17.0	16.8	16.5
Lost workday cases	7.3	7.2	7.2
Lost workdays	--	--	--
Fabricated metal products:			
Total cases	16.2	16.4	15.8
Lost workday cases	6.7	6.7	6.9
Lost workdays	--	--	--
Industrial machinery and equipment:			
Total cases	11.1	11.6	11.2
Lost workday cases	4.2	4.4	4.4
Lost workdays	--	--	--
Electronic and other electrical equipment:			
Total cases	8.3	8.3	7.6
Lost workday cases	3.5	3.6	3.3
Lost workdays	--	--	--
Transportation equipment:			
Total cases	18.5	19.6	18.6
Lost workday cases	7.1	7.8	7.9
Lost workdays	--	--	--
Instruments and related products:			
Total cases	5.6	5.9	5.3
Lost workday cases	2.5	2.7	2.4

Lost workdays	--	--	--
Miscellaneous manufacturing industries:			
Total cases	10.0	9.9	9.1
Lost workday cases	4.6	4.5	4.3
Lost workdays	--	--	--
Nondurable goods:			
Total cases	10.7	10.5	9.9
Lost workday cases	5.0	5.1	4.9
Lost workdays	--	--	--
Food and kindred products:			
Total cases	17.6	17.1	16.3
Lost workday cases	8.9	9.2	8.7
Lost workdays	--	--	--
Tobacco products:			
Total cases	5.8	5.3	5.6
Lost workday cases	2.3	2.4	2.6
Lost workdays	--	--	--
Textile mill products:			
Total cases	9.7	8.7	8.2
Lost workday cases	4.1	4.0	4.1
Lost workdays	--	--	--
Apparel and other textile products:			
Total cases	9.0	8.9	8.2'
Lost workday cases	3.8	3.9	3.6
Lost workdays	--	--	--
Paper and allied products:			
Total cases	9.9	9.6	8.5
Lost workday cases	4.8	4.5	4.2
Lost workdays	--	--	--
Printing and publishing:			
Total cases	6.9	6.7	6.4
Lost workday cases	3.1	3.0	3.0
Lost workdays	--	--	--
Chemicals and allied products:			
Total cases	5.9	5.7	5.5
Lost workday cases	2.7	2.8	2.7
Lost workdays	--	--	--
Petroleum and coal products:			
Total cases	5.2	4.7	4.8
Lost workday cases	2.5	2.3	2.4
Lost workdays	--	--	--
Rubber and miscellaneous plastics products:			
Total cases	13.9	14.0	12.9
Lost workday cases	6.5	6.7	6.5
Lost workdays	--	--	--
Leather and leather products:			
Total cases	12.1	12.0	11.4
Lost workday cases	5.5	5.3	4.8
Lost workdays	--	--	--
Transportation and public utilities			
Total cases	9.5	9.3	9.1
Lost workday cases	5.4	5.	5.
Lost workdays	--	--	--
Wholesale and retail trade			
Total cases	8.1	7.9	7.5

Lost workday cases	3.4	3.4	3.2
Lost workdays	--	--	--
Wholesale trade:			
Total cases	7.8	7.7	7.5
Lost workday cases	3.7	3.8	3.6
Lost workdays	--	--	--
Retail trade:			
Total cases	8.2	7.9	7.5
Lost workday cases	3.3	3.3	3.0
Lost workdays	--	--	--
Finance, insurance, and real estate			
Total cases	2.9	2.7	2.6
Lost workday cases	1.2	1.1	1.0
Lost workdays	--	--	--
Services			
Total cases	6.7	6.5	6.4
Lost workday cases	2.8	2.8	2.8
Lost workdays	--	--	--

	Incidence rates per 100 full-time workers(3)		
Industry and type of case(2)	1996(4)	1997(4)	1998(4)
PRIVATE SECTOR(5)			
Total cases	7.4	7.1	6.7
Lost workday cases	3.4	3.3	3.1
Lost workdays	--	--	--
Agriculture, forestry, and fishing(6)			
Total cases	8.7	8.4	7.9
Lost workday cases	3.9	4.1	3.9
Lost workdays	--	--	--
Mining			
Total cases	5.4	5.9	4.9
Lost workday cases	3.2	3.7	2.0
Lost workdays	--	--	--
Construction			
Total cases	9.9	9.5	8.8
Lost workday cases	4.5	4.4	4.0
Lost workdays	--	--	--
General building contractors:			
Total cases	9.0	8.5	8.4
Lost workday cases	4.0	3.7	3.9
Lost workdays	--	--	--
Heavy construction, except building:			
Total cases	9.0	8.7	8.2
Lost workday cases	4.3	4.3	4.1
Lost workdays	--	--	--

Special trades contractors:			
Total cases	10.4	10.0	9.1
Lost workday cases	4.8	4.7	4.1
Lost workdays	--	--	--
Manufacturing			
Total cases	10.6	10.3	9.7
Lost workday cases	4.9	4.8	4.7
Lost workdays	--	--	--
Durable goods:			
Total cases	11.6	11.3	10.7
Lost workday cases	5.1	5.1	5.0
Lost workdays	--	--	--
Lumber and wood products:			
Total cases	14.2	13.7	13.2
Lost workday cases	6.8	6.5	6.8
Lost workdays	--	--	--
Furniture and fixtures:			
Total cases	12.2	12.0	11.4
Lost workday cases	5.4	5.8	5.7
Lost workdays	--	--	--
Stone clay and glass products:			
Total cases	12.4		
Lost workday cases	6.0	5.7	6.0
Lost workdays	--	--	--
Primary metal industries:			
Total cases	15.0	15.0	14.0
Lost workday cases	6.8	7.2	7.0
Lost workdays	--	--	--
Fabricated metal products:			
Total cases	14.4	14.2	13.9
Lost workday cases	6.2	6.4	6.5
Lost workdays	--	--	--
Industrial machinery and equipment:			
Total cases	9.9	10.0	9.5
Lost workday cases	4.0	4.1	4.0
Lost workdays	--	--	--
Electronic and other electrical equipment:			
Total cases	6.8	6.6	5.9
Lost workday cases	3.1	3.1	2.8
Lost workdays	--	--	--
Transportation equipment:			
Total cases	16.3	15.4	14.6
Lost workday cases	7.0	6.6	6.6
Lost workdays	--	--	--
Instruments and related products:			
Total cases	5.1	4.8	4.0
Lost workday cases	2.3	2.3	1.9
Lost workdays	--	--	--
Miscellaneous manufacturing industries:			
Total cases	9.5	8.9	8.1
Lost workday cases	4.4	4.2	3.9
Lost workdays	--	--	--
Nondurable goods:			
Total cases	9.2	8.8	8.2
Lost workday cases	4.6	4.4	4.3
Lost workdays	--	--	--
Food and kindred products:			
Total cases	15.0	14.5	13.6

Lost workday cases	8.0	8.0	7.5
Lost workdays	--	--	--
Tobacco products:			
Total cases	6.7	5.9	6.4
Lost workday cases	2.8	2.7	3.1
Lost workdays	--	--	--
Textile mill products:			
Total cases	7.8	6.7	6.7
Lost workday cases	3.6	3.1	3.4
Lost workdays	--	--	--
Apparel and other textile products:			
Total cases	7.4	7.0	6.2
Lost workday cases	3.3	3.1	2.6
Lost workdays	--	--	--
Paper and allied products:			
Total cases	7.9	7.3	7.1
Lost workday cases	3.8	3.7	3.7
Lost workdays	--	--	--
Printing and publishing:			
Total cases	6.0	5.7	5.4
Lost workday cases	2.8	2.7	2.8
Lost workdays	--	--	--
Chemicals and allied products:			
Total cases	4.8	4.8	4.2
Lost workday cases	2.4	2.3	2.1
Lost workdays	--	--	--
Petroleum and coal products:			
Total cases	4.6	4.3	3.9
Lost workday cases	2.5	2.2	1.8
Lost workdays	--	--	--
Rubber and miscellaneous plastics products:			
Total cases	12.3	11.9	11.2
Lost workday cases	6.3	5.8	5.8
Lost workdays	--	--	--
Leather and leather products:			
Total cases	10.7	10.6	9.8
Lost workday cases	4.5	4.3	4.5
Lost workdays	--	--	--
Transportation and public utilities			
Total cases	8.7	8.2	7.3
Lost workday cases	5.1	4.8	4.3
Lost workdays	--	--	--
Wholesale and retail trade			
Total cases	6.8	6.7	6.5
Lost workday cases	2.9	3.0	2.8
Lost workdays	--	--	--
Wholesale trade:			
Total cases	6.6	6.5	6.5
Lost workday cases	3.4	3.2	3.3
Lost workdays	--	--	--
Retail trade:			
Total cases	6.9	6.8	6.5
Lost workday cases	2.8	2.9	2.7
Lost workdays	--	--	--
Finance, insurance, and real			

estate			
Total cases	2.4	2.2	1.9
Lost workday cases	.9	0.9	0.7
Lost workdays	--	--	--
Services			
Total cases	6.0	5.8	5.2
Lost workday cases	2.6	2.5	2.4
Lost workdays	--	--	--

(1) Data for 1989 and subsequent years are based on the Standard Industrial Classification Manual, 1987 Edition. For this reason, they are not strictly comparable with data for the years 1985-88, which were based on the Standard Industrial Classification Manual, 1972 Edition, 1977 Supplement.

(2) Beginning with the 1992 survey, the annual survey measures only nonfatal injuries and illnesses, while past surveys covered both fatal and nonfatal incidents. To better address fatalities, a basic element of workplace safety, BLS implemented the Census of Fatal Occupational Injuries.

(3) The incidence rates represent the number of injuries and illnesses or lost workdays per 100 full-time workers and were calculated as (N/EH) X 200,000, where:

N = number of injuries and illnesses or lost workdays;

EH = total hours worked by all employees during the calendar year; and

200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

(4) Beginning with the 1993 survey, lost workday estimates will not be generated. As of 1992, BLS began generating percent distributions and the median number of days away from work by industry and for groups of workers sustaining similar work disabilities.

(5) Excludes farms with fewer than 11 employees since 1976.

-- Data not available.

47. Fatal occupational injuries by event or exposure, 1993-98

Event or exposure(1)	Fatalities 1993-97 Average	1997(2) Number
Total	6,335	6,238
Transportation Incidents	2,611	2,605
Highway incident	1,334	1,393
Collision between vehicles, mobile equipment	652	640
Moving in same direction	109	103
Moving in opposite directions, oncoming	234	230
Moving in intersection	132	142
Vehicle struck stationary object or equipment	249	282
Noncollision incident	360	387
Jackknifed or overturned--no collision	267	298
Nonhighway (farm, industrial premises) incident	388	377
Overturned	214	216
Aircraft	315	261
Worker struck by a vehicle	373	367
Water vehicle incident	106	109
Railway	83	93
Assaults and violent acts	1,241	1,111

Homicides	995	860
Shooting	810	708
Stabbing	75	73
Other, including bombing	110	79
Self-inflicted injuries	215	216
Contact with objects and equipment	1,005	1,035
Struck by object	573	579
Struck by falling object	369	384
Struck by flying object	65	54
Caught in or compressed by equipment or objects	290	320
Caught in running equipment or machinery	153	189
Caught in or crushed in collapsing materials	124	118
Falls	668	716
Fall to lower level	591	653
Fall from ladder	94	116
Fall from roof	139	154
Fall from scaffold, staging	83	87
Fall on same level	52	44
Exposure to harmful substances or environments	586	554
Contact with electric current	320	298
Contact with overhead power lines	128	138
Contact with temperature extremes	43	40
Exposure to caustic, noxious, or allergenic substances	120	123
Inhalation of substances	70	59
Oxygen deficiency	101	90
Drowning, submersion	80	72
Fires and explosions	199	196
Other events or exposures(3)	26	21

Event or exposure(1)	Fatalities 1998 Number	Percent
Total	6,026	100
Transportation Incidents	2,630	44
Highway incident	1,431	24
Collision between vehicles, mobile equipment	701	12
Moving in same direction	118	2
Moving in opposite directions, oncoming	271	4
Moving in intersection	142	2
Vehicle struck stationary object or equipment	306	5
Noncollision incident	373	6
Jackknifed or overturned--no collision	300	5
Nonhighway (farm, industrial premises) incident	384	6
Overturned	216	4
Aircraft	223	4
Worker struck by a vehicle	413	7
Water vehicle incident	112	2
Railway	60	1
Assaults and violent acts	960	16

Homicides	709	12
Shooting	569	9
Stabbing	61	1
Other, including bombing	79	1
Self-inflicted injuries	223	4
Contact with objects and equipment	941	16
Struck by object	517	9
Struck by falling object	317	5
Struck by flying object	58	1
Caught in or compressed by equipment or objects	266	4
Caught in running equipment or machinery	129	2
Caught in or crushed in collapsing materials	140	2
Falls	702	12
Fall to lower level	623	10
Fall from ladder	111	2
Fall from roof	156	3
Fall from scaffold, staging	97	2
Fall on same level	51	1
Exposure to harmful substances or environments	572	9
Contact with electric current	334	6
Contact with overhead power lines	153	3
Contact with temperature extremes	46	1
Exposure to caustic, noxious, or allergenic substances	104	2
Inhalation of substances	48	1
Oxygen deficiency	87	1
Drowning, submersion	75	1
Fires and explosions	205	3
Other events or exposures(3)	16	--

(1) Based on the 1992 BLS Occupational Injury and Illness Classification Structures.

(2) The BLS news release issued August 12, 1998, reported a total of 6,218 fatal work injuries for calendar year 1997. Since then, an additional 20 job-related fatalities were identified, bringing the total job-related fatality count for 1997 to 6,238.

(3) Includes the category "Bodily reaction and exertion."

NOTE: Totals for major categories may include subcategories not shown separately. Percentages may not add to totals because of rounding. Dash indicates less than 0.5 percent.

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Industry Codes/Names: BUSN Any type of business
Descriptors: Labor economics--Statistics; Industrial productivity--Statistics; Consumer price indexes--Statistics; Labor supply--Statistics; Employment--Statistics ; Economic indicators--Statistics
Geographic Codes: 1USA United States
File Segment: MI File 47

30/9/23 (Item 23 from file: 148)
12806080 Supplier Number: 66966504 (THIS IS THE FULL TEXT)

AN EVALUATION OF MONETARY TARGETING REGIMES.(Euro Area)(Statistical Data

Included)

Barrell, Ray; Dury, Karen
National Institute Economic Review , 105
Oct , 2000
Document Type: Statistical Data Included
ISSN: 0027-9501
Language: English
Record Type: Fulltext
Word Count: 6556 Line Count: 00510

Text:

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The policy regime in Europe has put the economy on 'auto-pilot'. We investigate different designs for the required feedback mechanisms. The uncertainty facing an economy depends on the pattern of shocks it faces, the response of the private sector to those shocks and also the policy reactions of the authorities. Two 'ideal type' policy regimes are investigated, and inflation targeting is compared to nominal aggregate targeting. In general it is suggested that targeting a nominal aggregate reduces the variability of the price level, and stabilises the price level more quickly overtime. Inflation outcomes are also less variable for the Euro Area, and they are less asymmetric when a nominal aggregate is targeted. The new European fiscal framework requires that countries set deficit targets close to balance. We show that there is plenty of space for automatic stabilisers to work, but the room available depends in part on the monetary policy framework chosen.

Introduction

The European policy debate has moved on from discussions of how we might form a Monetary Union to how one might be operated. This debate involves the discussion of both monetary and fiscal policy. There are many approaches to both, and much of the postwar consensus was based on the presupposition that there would always be a role for positive action, or discretionary policy, designed to stabilise the economy. It is not clear that discretionary action has always been stabilising, and indeed there are many examples where it has not been. (1) The debate in Europe has pushed policy towards the use of simple rules, or at least clear frameworks for the operation of rules. These are designed to limit the scope for discretionary policy and also circumscribe the role of government in the Union. Policymakers face dilemmas when faced with elections, and they may undertake sets of policies that are, over time, inconsistent. Legally enforceable frameworks for action, such as the Stability and Growth Pact, represent (simpl e) rule based pre-commitment strategies, and these are discussed at length in Buti and Sapir (1998), Dury and Pina (2000) and in Buti and Martinot in this Review. The creation of an independent Central Bank can also be interpreted as a pre-commitment strategy, and the European Central Bank has been relatively clear that it regards its role as following a strategy that we believe could be encapsulated in a simple rule.

It is possible to implement these strategies on a model of the economy and evaluate how they might influence the outcomes in response to, or in dealing with, a sequence of **random** shocks to the structure. These sequences of shocks can be applied in a number of ways, and the most systematic involve the use of the stochastic simulation techniques applied in our results. (2) The National Institute Global

Econometric Model, NiGEM, (3) is repeatedly simulated with different starting assumptions and solved over the whole of the future on the baseline, which currently runs out beyond 2020. Each set of assumptions represents a **randomly** chosen drawing from the sets of residuals on our model equations. All of the residuals, or unexplained components, used for one simulation come from the same time period. (4) The model is run in forward mode so that news induces forward-looking variables to jump to new equilibria. (5) We repeat this process 200 times or so in order to get a stable and reliable estimate of the distributi on of potential outcomes.

The simple feedback rules used in our models and by others are often described as closure rules, and even an empirically well-described economy is not complete (closed) without a reasonable description of the behaviour of the authorities. Large-scale macro-models of the economy need monetary closure rules even more than they need fiscal closure rules, as many analyses cannot be sensibly undertaken without some knowledge of the response of the monetary authorities. There are two classes of monetary policy rule that can be used in large models and by policymakers, and they have different implications. There are those that tie a nominal aggregate or variable down in the long run, including fixed exchange rate rules, money stock guidelines, nominal GDP targeting (6) and price level targeting. There are others that feed back on the inflation rate, and stabilise it in the long run. The latter class in general imply that the price level will follow a **random** walk whilst the former class do not. The distinction betwee n these two classes of rules is brought out in a previous paper (Barrell, Dury and Hurst, 1999a).

In this article we analyse simple monetary feedback rules and their role in stabilising output, inflation and the price level. The paper in this issue of the Review by Gaspar and Smets highlights the results of the recent theoretical literature on price level versus inflation targeting. The conventional wisdom is that price level targeting can be costly in terms of output and inflation variability and that inflation targeting is the superior policy rule to follow. More recently there has been renewed focus on price level targeting and whether targeting the price level can help stabilise inflation expectations, which in turn will stabilise actual inflation. The conventional wisdom was based on the assumption that agents were backward looking, but recent research based on expectations being forward looking has given extra insights. In particular it has made it clear that price level related objectives are credible and efficient ways of stabilising the economy.

We also present an overview of a sequence of papers designed to investigate the stochastic nature of the economy when faced by differently designed monetary control rules. Our research has given us a number of insights into the nature of the problems facing both the ECB and the Bank of England, and our objective is to survey and summarise them. In Barrell, Dury and Hurst (1999a, b) we explore the stabilisation properties of the two types of policy rules (nominal targets versus inflation) on NiGEM and we evaluate outcomes in terms of output, inflation and the price level. We summarise the pattern of results for four of the major economies that operate independent monetary policies, the UK, US, Japan and the Euro Area.

Gaspar and Smets, in this Review, discuss theoretical results. They address the issue of the choice of the 'best' policy rule; and present a case for including price stability as a primary objective. They also discuss the horizon over which the price stability objectives are pursued and the degree to which nominal rigidities affect the conclusion. This discussion has many consonances with our programme of research and we summarise further work undertaken by Barrell and Dury (2000b) concerning these issues. In particular, Barrell and Dury (2000a) discuss the role of labour market rigidities in determining the outcomes that Europe could face in response to shocks.

There are many other issues that are of interest to policymakers that can be effectively evaluated using stochastic simulations on large

models. Buti and Martinot, in this issue of the Review, are concerned with the implementation of the Stability and Growth Pact (SGP). We discuss the appropriate choice of fiscal targets within the constraints of the SGP, and in particular what would prevent the European countries from exceeding the 3 per cent of GDP ceiling imposed by the Pact while allowing automatic stabilisers to work freely. (see Barrell and Dury, 2000c, Barrell and Pina, 2000, and Dury and Pina, 2000). We also discuss the possibility of 'liquidity traps' and show that the risk of significant deflationary spirals is reduced if a nominal aggregate is targeted.

Nominal magnitude or inflation targeting

The range of interest rate feedback rules available for policy **analysis** is large, and we only discuss two possible alternatives here. The ECB's strategy can be represented by a simple equation that represents its behaviour. Inevitably this will be an idealised description of the actual process of decision making. The ECB has attempted to make its objectives clear, and it can be described as taking account of two broad issues, the evolution of nominal aggregates in the medium term and the emergence of inflationary and deflationary pressures in the short term. This 'two-pillar' strategy rests on the evaluation of developments in a de-trended reference **value** for Euro Area M3 combined with a concern for short-term inflationary developments. The ECB also stresses that its role is to maintain price stability in the medium term, and hence the monetary aggregate must not be seen as an end in itself, but rather as an intermediate indicator that gives information of the ultimate target, the trajectory for the price lev el. Gaspar and Smets, in this Review, stress this aspect of the EGB's approach to targeting. They also argue that price level targeting can be complementary to both output and inflation stabilisation if inflation expectations are sufficiently forward-looking and an appropriate policy horizon is chosen.

Our 'ideal-type' representation of the strategy of the ECB can be based around a nominal GDP aggregate (7) and an inflation rate deviation from target. We can write an interest rate feedback rule as

$$r = \lambda_1 (p_t y_t - (p_t y_t)^*) + \lambda_2 (dp_{t+j} - dp^*_{t+j})$$

where p is the price index, dp is its per cent rate of change, y is real output and j is the forecast lead in the evaluation of inflation prospects, and a * denotes a target variable. In this article our results are based on the assumption that the current inflation rate enters the target rule. As Blake in this Review shows, the inclusion of a forward term is not significantly different from the use of a current term in forward-looking models such as NiGEM. If the feedback on inflation is zero then we have a nominal aggregate targeting rule (denominated NOM in our tables) and if alternatively the feedback on the nominal aggregate is zero we have a pure inflation-targeting regime (denoted INF in our tables). The nominal aggregate regime has many similarities to price level targeting as long as there are no systematic shocks that alter the long-run supply potential of the economy. It is possible to evaluate these two regimes, and we discuss some of our more relevant results from the extended discussion in Barre ll, Dury and Hurst (1999a, b) in Table 1.

We show that, when we move from a nominal aggregate targeting rule to a direct inflation targeting rule, output variability is generally increased and inflation variability is generally reduced compared to a simple nominal targeting rule, however without exception, inflation targeting increases price level variability. In Barrell and Dury (2000b) we discuss the conditions under which stability of the trajectory for the price level must be seen as an objective in itself. Output variability is lower for the US under inflation targeting than nominal targeting, reflecting both the relatively closed nature of the economy and the relative flexibility of markets. The economies that display more nominal inertia (or are also more open in the case of the UK) display less output variability with nominal targets in place. The Euro Area economies display

significantly more inertia in their labour markets and price setting than either the US or the UK, and hence they have significantly less inflation variability when we gi ve them a nominal target. The other more flexible economies have less variability in their inflation rates if they target inflation, much as we would expect from our discussion and from that in Gaspar and Smets. The price level is significantly more variable under inflation targeting in all economies, except the small open UK economy -- again, much as we would expect. We can conclude that nominal targeting is generally better at stabilising output and price level variability, but targeting inflation directly can be superior in stabilising inflation variability except in larger, less flexible closed economies.

The results in Table 1 are not sufficient to allow us to say what we might consider to be the 'best' targeting strategy. It is likely that policymakers will not focus solely on the variability of one variable and will be concerned with the variability of both output and inflation rates and so both will appear in their loss functions. They may also believe that other non-price variables are an indication of economic welfare. Indeed it is possible that a central bank that considers price stability in the medium term to be its underlying objective might see the stability of the price level as its major yardstick for evaluating policy regimes. Instrument instability may also be seen as a problem. In particular, large and frequent fluctuations in the interest rate may be regarded as imposing costs on the economy and so may be included in the loss function and this may change the conclusions about the relative performance of the policy rules. However, for illustration we concentrate on the output, inflation and the price level. The outcome of any loss function will depend on the relative weights on its arguments. Where the loss function has more than one argument, then equal weight is placed on each. In Table 2 we compare the results for each of the models discussed above.

In evaluating policy rules we 'add' together the variabilities in output, inflation and the price level, as can be seen in the table. As output appears significantly more variable than inflation in our trials (and in our draw period of 1993-7), at first glance it appears to take a greater weight. However, this is not the case. The table shows that the UK and Japan will almost always choose the nominal rule and it is always the preferred rule when policymakers have more than one objective in their loss function, which we presume always includes (the more variable) output. The Euro Area would always choose the nominal rule and US would almost always choose the inflation targeting rule except in the situation where price level stability takes precedence. It is clear that the preferred rule depends on the structure of the economy and on the objectives of the authorities. Policy regimes that are appropriate for small open economies or very flexible ones may not be the best choice for large and inflexible groupings such as the Euro Area.

Short or medium-term objectives -- appropriate policy horizon

Central banks should not and do not just worry about events in the quarter ahead. Instrument stability matters, and reacting too rapidly to offset a shock can be destabilising for the **financial** markets and for other decision-makers facing constraints. Policy should be judged in terms of its ultimate success in stabilising the objectives of the authorities and also in terms of its contribution to the growth of the economy. Environments where longer-term contracts can safely be made in real terms are probably better for enhancing growth than are the alternatives. Hence we should look carefully at the horizon over which policy should be judged. It is possible that inflation targeting is better at stabilising targets in the short run and price level targeting is better at this task in the medium to long term. In addition, we can posit that greater price level certainty aids the construction of longer-term contracting relationships. Our results can shed light on these issues. The first two columns in Table 3 prese nt the RMSDs (8) for each country in the first and last year of the simulations under each rule. The third column shows the variability of the price level under inflation targeting compared

with its variability under the nominal-targeting rule as an index with the latter rule having a **value** of 100. In general price level uncertainty, as indicated by the variability of the price level, increases the more one moves into the future. The increase in price level uncertainty over time is greater when one uses inflation targeting in the US, Japan and the Euro Area. This result for the larger economies is not replicated in the small, open UK.

We can argue that there is a good case for stressing the medium-term stability of the trajectory for the price level, and that in particular the framers of the Bundesbank and ECB constitutions had this concept in mind when setting them up. Indeed, we have argued in Barrell and Dury (2000b) and Barrell, Dury and Hurst (1999b), that price level stability takes a primary place in the objectives of these institutions with other objectives being clearly secondary.

In order to assess the medium-term price stabilising properties of the regimes we consider, we should look at the variability of the price level in the first year and in the final year (year five) of our trials. We would argue that the objective of medium-term price stability is better judged by the stability of the final, not the period average, price level as presented in the previous section. The nominal aggregate target does significantly better in stabilising the price level at the end of the trial period than does inflation targeting on its own. Hence the mean reverting properties of a rule that contains a nominal aggregate are clear in Table 3, as prices are being taken back to their baseline trajectory more reliably in the experiments with the nominal rule than with the inflation targeting rule.

Balance of risks

It is often assumed that risks are symmetrical around a forecast, and hence we can construct error bounds in this way. Constructing 95 per cent confidence **intervals** around the mean forecast using the RMSD from the stochastic simulations can be done by assuming errors are normally distributed. This would imply that the degree of forecast uncertainty is identical above and below the mean forecast. However, stochastic simulations give us a more effective way of assessing the balance of risks. The balance of risks in a forecast also involve forecasting judgements, and we do not consider those here. Stochastic simulations help us put bounds around our central forecast based on past errors from structural equations. These are a useful adjunct to forecast judgements on the symmetry of risks. We can calculate the range within which 95 per cent of the outturns fall and Charts 1 and 2 show the forecast error bounds calculated using stochastic outturns for Euro Area inflation over time under nominal aggregate targeting and under inflation targeting. (9)

The three lines on each chart represent the absolute differences of the error bounds from the forecast mean. The dotted line represents the 95 per cent confidence bound using the RMSD and assuming symmetry. The thin solid line and the dark solid line represent the absolute difference between the mean, and the upper and lower 95 per cent confidence ranges respectively. Both charts clearly show that the further out into the forecast the wider the confidence bounds become around the forecast mean, indicating that uncertainty in the forecast increases significantly over time. The degree of uncertainty around the forecast clearly rises for the first eight to ten quarters of our projections and then essentially stabilises.

The charts can also provide evidence as to whether the risks are skewed in one direction and whether the balance of risks changes over the rules. For example, under both rules the upper 95 per cent confidence band for inflation in the Euro Area is below the error band calculated using the RMSD assuming symmetry and the lower range band is above it. Chart 2 shows that in the first quarter under inflation targeting, if the mean forecast for inflation were 2.0 the upper bound would be 2.4 and the lower bound would be 1.4. Therefore the difference between the upper range and the mean

is less than the difference between the lower range and the mean for both rules. This indicates that the distributions of results are skewed with a long negative tail for inflation rates. When risks are unbalanced, the mean forecast will not be the same as the median **value**. For the Euro Area it appears that the probability distribution is left skewed (or negatively skewed) under both rules indicating that more of the results lie abov e the mean. Hence there is a higher probability of being above the mean inflation than below, but that this is compensated by some particularly low potential values for inflation. Clearly our rules should be set so as to reduce the possibility of asymmetric outcomes as they make **financial** and other decision making more difficult. In particular, price level targeting can reduce the possibility of long negative tails, as Gaspar and Smets argue. We show in the charts that under the nominal aggregate targeting rule, the upper and lower 95 per cent confidence ranges are closer together than they are under the inflation targeting rule. This implies that there is a longer negative tail for Euro Area inflation under inflation targeting in our stochastic simulations than there is under the nominal aggregate rule.

We can judge the degree of asymmetry in the distribution of inflation outcomes by comparing the mean and the median. In a symmetric distribution the two are the same. In the first few years of the forecast the mean is 0.29 points below the median for inflation targeting and 0.19 under the nominal rule, whilst in the last year the results are similar under both rules. The difference in the balance of risks between the two rules is particularly noticeable in the middle year of the forecast where the mean is 0.33 points below the median for inflation targeting and 0.12 under the nominal rule. This suggests that the risks of a liquidity trap are greater in the early years of the current decade under both rules and the risks are greater still if inflation targeting is used. If inflation in the Euro Area falls significantly below baseline in a stochastic replication, interest rates cannot necessarily follow it down, as they cannot fall below zero. Hence in any replication there is a significant probability that the country could be in a liquidity trap. The resulting distribution of the inflation outcome is skewed downward under both rules, with a long negative tail. If inflation falls, interest rates follow it and offset it by expanding demand. Hence the existence of a liquidity trap increases the risk of significant deflationary spirals and we show that this risk is reduced if a nominal aggregate is targeted.

Do rigidities matter for the rule?

We have discussed the importance of rigidities in the economy in determining the choice of rule and the distribution of potential outcomes. A number of papers in the recent literature argue in favour of reducing the variability of the price level in response to shocks as it will minimise the distortions due to the differing abilities of firms in the economy to adjust their prices. This literature, summarised by Gaspar and Smets in this Review, points out that the degree to which the shock to the price level should be reversed depends on the contracting structure of the economy. The longer the length of an average contract, the greater will be the incentive for the central bank to reverse the effects on the price level. Therefore the longer the length of contracts and hence the greater degree of inertia in the economy the more a central bank will favour price level targeting. In this section we relate this discussion to our own work on labor markets in Europe. We show that the more inertia in the labour market s the more a central bank will start to favour a price level targeting rule compared with an inflation-targeting rule.

In Barrell and Dury (2000a), we construct three different models of European labour markets; one where the labour market relationships are separately estimated and assumed to be different, one where the most statistically acceptable commonalties are imposed and one where common labour market relationships are imposed across all member countries. We use panel estimation techniques to test for the imposition of commonalties among countries. We find that it is possible to divide Europe into

subgroups but it is not possible to have one model of European labour markets. We find that as we impose commonalties among countries we introduce substantial amounts of inertia in the wage determination process. The more inertia that is introduced into the labour markets, the more a nominal aggregate targeting rule alone may be preferred. Here we omit the intermediate case, Model 2, and present results for the two extreme models; Model 1 is where all relationships are estimated, in Model 3 we impose commonalties across all c ountries, thereby specifying one single underlying relationship for the European wage setting process.

The results for The Euro Area and the UK are presented in Table 4 as an index **value** for Model 3 where Model 1 is given a **value** of 100. They show that as we move from Model 1 to Model 3, the nominal targeting rule improves its performance in stabilising output, inflation and the price level compared with the pure inflation targeting rule. The nominal aggregate rule performs considerably better at stabilising output and inflation in a more inertial economy in the Euro Area, whilst inflation targeting worsens its performance on these two criteria. Price level variability is reduced with inflation targeting as the Euro Area economy becomes more inertial, but not to the same degree as under nominal targeting. Price level variability in the UK under inflation targeting increases as the economy becomes more inertial, but declines under a nominal aggregate rule. In general we can see that nominal rules, and in particular price level rules, are preferred the more inertial the economy we investigate, much as Gaspar and Smets in this Review suggest.

Fiscal stance in EMU

Buti and Martinot in this Review discuss the fiscal aspects of the new policy regime in Europe. The Stability and Growth Pact (SGP) puts clear limits on the size of deficits that can be run, and has a rather loose system of fines associated with it. The Pact sets a deficit of 3 per cent of GDP as a floor, and if deficits of 3 per cent are maintained then there is a system of fines. One of the most common criticisms of the SGP is that it may be too binding in that governments will be unable to use fiscal stabilisation policies as the 3 per cent ceiling may curtail the workings of the automatic stabilisers in the economy. It is possible to investigate this claim using stochastic simulations or our world model, NiGEM.

Barrell and Dury (2000c) present extensive results on Fiscal issues and also discuss the recent literature on the appropriate targets for government budget deficits. Some simple descriptive statistical analyses have been undertaken based on retrospective evidence. The work in Buti and Sapir (1998), for instance, broadly suggests that the European economies could operate well within the SGP guidelines if they broadly followed a balanced budget and some, such as the Nordic economies, should aim for a surplus. These results depend on the observed volatilities of both the economies in question and their budget deficits and they probably paint too pessimistic a view of the constraints governments face. In particular, he Nordic economies exhibited volatile business cycles in the 1970s and 1980s into the early 1990s because they went through a sequence of devaluation induced booms and downturns. These are no longer possible to generate in quite the same idiosyncratic way given monetary policy commitments in Finland, Denmark and Sweden.

We investigated this issue in a number of papers using stochastic simulations on NiGEM (See Barrell, and Dury (2000c), Barrell and Pina (2000) and Dury and Pina (2000). The probabilities of breaching the SGP was calculated and in all three papers the conclusion that the targets for the government deficit announced in the programme was compatible with the automatic stabilisers working freely and that they could cope well in stabilising the economy given a variety of shocks. Clearly the closer to zero the target deficit, the easier it would be for fiscal stabilisers to work.

In Barrell and Dury (2000c) we calculate the target deficit required for there to be only a 1 per cent chance of exceeding the SGP 3 per cent ceiling. The stochastic simulations give us the variabilities of the

government budget ratio and from this we can calculate the required mean target for each country. Table 5 below presents these results for each country. We include the UK, Greece and Sweden. We show that the level of the government budget deficit required for a 1 per cent chance of exceeding the 3 per cent limit without constraining the automatic stabilisers built into the model is relatively high compared with most other estimates, as discussed by Buti and Martinot. For example, an econometric **analysis** by Dalsgaard and de Serres (1999), reports appropriate medium-term target deficits of the order of 1-1.5 per cent of GDP for the majority of the European economies. Finland, UK, Denmark and Sweden are estimated to require moderate surpluses to keep within the SGP criteria. Our results suggest that the main European economies can run much looser deficit targets. These estimates are also much higher than those from the IMF (1998) and OECD (1997).

The results based on stochastic simulations have the advantage of being based on a model of the European economies that we think will exist in the future with a policy environment that is a reasonable idealised description of the current framework. They should therefore be reasonably robust to criticism of not taking account of structural changes in the economy and in policy regimes, whilst those based on **historical** outturns are riddled with such problems. Our results suggest that only Sweden and Austria need to run near balanced budgets to allow the automatic stabilisers on our model to operate without breaching the 3 per cent of GDP deficit limit. We show the results over the two types of policy rules that we are considering here. We show that, for the core Euro Area economies, targeting an inflation rate requires a tighter deficit target trajectory as this strategy increases interest rate volatility and hence the volatility of government debt interest payments.

Setting target deficits 'close to balance', as in the Pact, can be seen as aiming for a target range of 0-1 per cent of GDP, therefore the 'safe' budget targets shown in Table 5 would suggest room for much stronger automatic stabilisers than we have operating on our model. There are three possible effects of the economic cycle on the budget, in that tax revenues automatically rise with incomes and expenditures on items such as unemployment insurance automatically fall, and also as revenues improve there are political pressures to lean with the wind and cut taxes and raise spending. The first two are best described as automatic stabilisers. Our model has similar effects of the cycle on unemployment related transfers and other spending to those in van den Noord (2000), but probably has smaller cycle related tax elasticities. Barrell and Pina (2000) embed the 'industry standard' tax elasticities into the model and show that the volatility of the deficit increases somewhat, but not enough to make target deficits in the range 0-1 per cent of GDP induce more than the very occasional breach of the SGP. There is clear scope within the current arrangements for the unfettered operation of automatic stabilisers. However, there are good reasons to be cautious and set target deficits closer to zero than those in Table 5.

The 'close to balance' rule can also be seen as being designed to offset some of the potential bias introduced into the budgetary system by bureaucratic offsets discussed, for instance, in Melitz (1997). There is clear evidence in Melitz that expenditures exhibit a pro-cyclical pattern, as budgetary constraints become looser when revenues are strong. This should mean that the target balance has to be set to take account of the asymmetric nature of the outturns for the deficit, especially if **financial** market based constraints on government behaviour have been released by the formation of EMU. We would presume, as in the 1980s and 1990s, governments will find it difficult to run surpluses even when they are appropriate to the cyclical position. Hence a tighter target than that implied in Table 5 would be appropriate, and it would allow automatic stabilisers to work fully in recessions and allow some offset for bureaucratic laxity in upturns. We would conclude that deficits around 1 per cent of GDP would be suit able for almost all countries in EMU.

Conclusions

We have discussed a variety of research areas undertaken at the National Institute of Economic and Social Research on monetary policy rules using stochastic simulations on NiGEM. We have shown that there is a strong case for following a targeting rule that ties down the nominal aggregate in terms of stabilising output, inflation and the price level. If society cares about output and inflation variability together then a nominal targeting rule is almost always chosen. The one exception is the large open economy of the US which may favour an inflation targeting rule. We also show that a nominal target is superior to an inflation target in the medium term at stabilising the price level trajectory in the economy. Nominal rigidities are also important in determining the best policy rule and the more inertial the economy the more a policymaker would favour a nominal targeting rule to stabilise the economy. Further results from stochastic simulation studies using NiGEM have shown that the targets set in the Stabilit y and Growth Pact may be too tight. The Euro Area countries could either run larger deficits and still stay within criteria without constraining the automatic stabilisers, or they could strengthen the automatic stabilisers in order to compensate for their loss of monetary independence.

* National Institute of Economic and Social Research. We would like to thank the ESRC for support under grant nos. R022250166 'Do Small Differences Matter? The structure and consequences of macroeconomic differences between members of EMU' and also Project LI38250122 'Fluctuations and Long-Term Prosperity: a study of the UK and International Economies'. We have benefited from cooperation with Paul Ashworth, Joe Byrne, Dawn Holland, Dirk te Velde, Andy Blake and especially Ian Hurst and Nigel Pain.

NOTES

(1.) Barrell (2000) discusses a number of such cases.

(2.) Clements and Hendry (1998) Ch. 5 discuss these techniques fully.

(3.) For details of the model used see NIESR (1999).

(4.) The draw period for **historical** shocks is 1993 to 1997 in the results reported here.

(5.) The outcomes of the shocks are stacked up for 20 quarters, with shocks being applied to each quarter using the post shock outturn from the previous quarter as a baseline.

(6.) The class also includes using the change in the interest rate to target the level of inflation.

(7.) Detrended M3 aggregate will move in line with nominal GDP, for instance.

(8.) The root of the summed, squared and averaged deviation of outturn from baseline.

(9.) Inflation targeting is measured as the annualised rate of inflation. A more detailed discussion can be found in Barrell, Dury and Pain (2000).

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30/9/24 (Item 24 from file: 148)
12754209 Supplier Number: 66499086 (THIS IS THE FULL TEXT)

A THEORY OF QUALITY-RELATED DIFFERENCES IN RETAIL MARGINS: WHY THERE IS A "PREMIUM" ON PREMIUM GASOLINE.(Brief Article)(Statistical Data Included)

BARRON, JOHN M.; TAYLOR, BECK A.; UMBECK, JOHN R.
Economic Inquiry , 38 , 4 , 550
Oct , 2000
Document Type: Brief Article Statistical Data Included
ISSN: 0095-2583
Language: English
Record Type: Fulltext
Word Count: 11544 Line Count: 00979

Text:

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This paper develops a theory of vertical and horizontal product differentiation to explain observed price-cost margin differentials for goods that differ in quality. The difference in price-cost margins between the high- and low-quality good is shown to depend positively on consumers' average **valuation**lt; for incremental increases in quality and positively on the distance to each competitor's closest rival. These predictions are largely supported using an extensive station-level data set of premium and regular unleaded gasoline prices from the Los Angeles Basin area from 1992-1995. (JEL D43, L13, L15)

I. INTRODUCTION

The focus of this article is to develop and test a theory of margin differentials related to quality. To illustrate, consider the existence of price-cost margin differentials in retail gasoline markets. Within the Los Angeles Basin area, for instance, the average dealer margin for self-service premium unleaded gasoline was 58.7% higher than the average margin for self-service regular unleaded gasoline for the 1992-1995 period. (1) Figure 1 illustrates the changes in the margin differential between premium and regular during this period as well as the margin differentials between premium and midgrade and between midgrade and regular unleaded. Table I confirms the significance of these margin differentials for both major and independent brands for the years 1992-1995.

Section II develops a multiproduct Hotelling model of two horizontally differentiated sellers, each selling two vertically differentiated products. (2) Four cases are examined: (1) the case in which all consumers purchase at the equilibrium set of prices and travel costs are not correlated with the **valuation**lt; of quality; (2) the case suggested by Katz (1984) in which travel costs are positively correlated with quality **valuation**lt;; (3) the case in which some consumers do not purchase at the equilibrium set of prices; and (4) an extension of the third case to three products. We contrast the first case with the second and third to highlight two distinct reasons for the prediction of a higher margin for the high-quality good. We contrast the third and fourth cases to examine the effects on margins of the introduction of an intermediate-quality good into the product mix.

In the second or third case, higher margins for the high-quality good reflect less elastic demand. (3) In the second case, the correlation between travel costs and the **value**lt; individuals place on improved quality results, to use the terminology of Holmes (1989), in a lower "competitor cross-price elasticity" for the high-quality good and thus a higher margin for the high-quality good. (4) In the third case, the customers that do not purchase at the equilibrium set of prices are those who place a low **value**lt; on quality. (5) Thus, from the point of view of any particular seller, a price increase for the low-quality product will lead to a loss in buyers not only as customers switch to other sellers and to the higher-quality product but also as customers simply choose not to purchase in that period (i.e., exit the market). (6) To use the terminology of Holmes, the fact that the "industry-demand price elasticity" is now positive for the lower-quality good but remains zero for the higher-quality good leads to a more elastic demand, and thus a lower margin, for the low-quality product. (7)

Either a model that assumes a positive correlation between travel costs and quality **valuation**lt; or one that assumes the potential for consumer exit predicts that the difference between the margin for the high-quality good and the margin for the low-quality good will depend on the proximity of rival sellers, the distribution of consumers' taste for quality, the level of wholesale prices, excise taxes, and the introduction of a third, intermediate-quality product. Section III reports results from empirical tests of these hypotheses using data from the Los Angeles gasoline market. For our test of margin differentials, the high-quality good is premium unleaded gasoline and the low-quality good is regular

unleaded gasoline.

Each year, Whitney-Leigh Corporation, a gasoline data collection company, surveys and records the location of every retail gasoline station in the greater Los Angeles area, a market that includes more than 4,000 stations. For the 1992-1995 period, we have entered the latitude and longitude of each station in this annual market survey, allowing us to identify precisely the location of each station and its distance from other competitors. Every two months, Whitney-Leigh undertakes a price survey of approximately 600 of these stations, recording the retail prices of each grade and service of gasoline. Another company, Lundberg Surveys, Inc., conducts weekly surveys of the wholesale prices (at the truck rack and delivered to the stations) in the Los Angeles area by grade and brand of gasoline. Finally, U.S. census data can be used to generate information on the demographic characteristics of individuals living close to each gasoline station. By combining these four data sets (Whitney-Leigh market survey, Whitney- Leigh retail price survey, Lundberg wholesale price survey, and census data), we have created a unique data set that identifies margins on different grades of gasoline, the distance of each retail gasoline station from its competitors, and the characteristics of potential buyers living close to each station.

This data set enables us to test the variety of implications generated by our model. In support of the theory, we find that as the distance to any given station's closest rival decreases by one-tenth of a mile, the difference between premium and regular unleaded margins decreases by approximately 0.25 cents per gallon, other things being equal. In addition, as the proxy for consumers' taste for quality, median household income, increases by $10,000, the margin differential between premium and regular unleaded gasoline increases by approximately 0.81 cents per gallon, other things remaining equal. We also find that increases in excise taxes and the existence of a midgrade unleaded gasoline widen the difference in margins between premium and regular unleaded gasoline.

II. THE MODEL

The objective of this section is to generate testable predictions concerning multi-product sellers. Given that the model will be tested using gasoline market data, we identify sellers as stations, the high-quality good as premium unleaded gasoline, and the low-quality good as regular unleaded gasoline. We begin by considering a simple model of two stations, each selling two products, and engaging in standard Hotelling-type competition. Our model follows the models presented by Katz (1984) and Gilbert and Matutes (1993) among others. However, we introduce two notable features. First, we introduce an explicit link between quality **valuation** by consumers and travel costs. Second, we consider the implications of expanding buyers' options to include the potential of not buying. As we show below, either of these two new features provides a rationale for different margins across products.

Consider a market in which two gasoline stations, j = {A, B}, are located distance D apart. These stations sell to N potential consumers distributed uniformly on a line between the two stations. A consumer located at point t on this line between the two stations is the distance (t.sup.j) from station j, where (t.sup.A) = t, and (t.sup.B) = D - t. Each station sells two products, i = {L, H}, where goods L and H can be interpreted as the low-quality (regular unleaded) and the high-quality (premium unleaded) products, respectively. Assume that each good can be fully characterized by its respective exogenous quality level, (q.sub.i). Without loss of generality, assume that (q.sub.H) (greater than) (q.sub.L) (greater than) 0.

Consumers in the market are identical except for their tastes for quality, indexed by s, and their location, t. A consumer with taste for quality s will have a reservation price for good i = {L, H} given by

(R.sub.i)(s) = w + s(q.sub.i),

where w can be viewed as the basic willingness to pay for the product. At each location t there exists an identical distribution of

consumers according to taste for quality. Let f(s) be defined as the density of consumers with taste for quality s, and let F(s) be defined as the proportion of consumers with a taste parameter less than or equal to s at each location, with the distribution of s defined over the support (s, s).

Potential consumers of gasoline are assumed to have unit demands per period. Each period, a potential buyer compares the prices of gasoline for different qualities and locations. The consumer picks the quality variant and station that generates the highest nonnegative consumer surplus. If the highest consumer surplus is negative, no gasoline is purchased that period. If a tie occurs between stations and/or grades, consumers choose at **random**. Thus, a consumer located at t with specific taste for quality s and per unit distance travel cost d buys product i from firm j if

(R.sub.i)(s) - (((p.sup.j).sub.i) + d(t.sup.j)) (greater than or equal to) (R.sub.x)(s) - (((p.sup.y).sub.x) + d(t.sup.y))

(forall)x = L, H and y = A, B,

and (R.sub.i)(s) - (((p.sup.j).sub.i) + d(t.sup.j)) (greater than or equal to) 0.

Full Coverage and Uncorrelated Travel Costs

We now consider the "benchmark" two-product duopoly model that assumes no consumers exit the market and a per-unit travel cost that is identical across individuals in the market. The no consumer exit, or "full-coverage," assumption means that a price increase by one seller results in a loss of customers only to the extent that they either purchase the other quality offered or purchase from the competing station. This situation occurs if w (greater than or equal to) w,) where w is sufficiently large to ensure that all N potential consumers have a nonnegative surplus from one of the two qualities at prevailing prices. Figure 2 illustrates the purchasing behavior of consumers based on their taste parameter and location for this case.

We define the taste parameter (s.sup.Hj) as the level at which the consumer is just indifferent between buying the low-grade and the high-grade gasoline from station j. As this taste parameter implies equality between the surplus from buying the low-quality gasoline versus the high-quality gasoline from station j, it is defined by

(s.sup.Hj) = (((p.sup.j).sub.H) - ((p.sup.j).sub.L))/((q.sub.H) - (q.sub.L)).

Similarly, by equating the surplus derived from buying gasoline of quality i from station A with that derived from buying the same quality of gasoline from station B, we can define

(t.sub.i) = (((p.sup.B).sub.i) - ((p.sup.A).sub.i))/2d + D/2

as the location of the consumer who is indifferent between buying gasoline of quality i from station A and station B.

Finally, if there is asymmetry in the prices of low- and high-quality gasoline across the two stations, then there are distance and taste parameter combinations that make the consumer indifferent between buying different grades of gasoline across the two stations. For instance, as illustrated in Figure 2, if station A has a relatively high price for the high-quality gasoline (i.e., ((p.sup.B).sub.H) - ((p.sup.B).sub.L) (less than) ((p.sup.A).sub.H) - ((p.sup.A).sub.L) such that (t.sub.H) (less than or equal to) (t.sub.L)), then the expression

s = (((p.sup.B).sub.H) - ((p.sup.A).sub.L) + d(D - 2t))/((q.sub.H) - (q.sub.L))

defines the combinations of taste parameter s and location t for consumers in the **interval** from (t.sub.H) to (t.sub.L) who are indifferent between purchasing the lower-quality gasoline at station A and the higher-quality gasoline at station B. Naturally, if station A has a relatively low price for the high-quality good, such that (t.sub.H) (greater than) (t.sub.L), then the expression

s = (((p.sup.A).sub.H) - ((p.sup.B).sub.L) - d(D - 2t))/((q.sub.H) - (q.sub.L))

defines the combinations of taste parameter and location for

consumers in the **interval** from (t.sub.L) to (t.sub.H) who are indifferent between purchasing the higher-quality gasoline at station A and the lower-quality gasoline at station B.

Consider the single-stage game in which stations A and B simultaneously choose the prices to charge for both grades of gasoline. Assume station j has constant marginal costs (c.sub.H) and (c.sub.L) of producing the quantities ((x.sup.j).sub.H) and ((x.sup.j).sub.L) of high- and low-quality gasoline sold each period. Given a fixed cost K, total costs are then given by

(C.sup.j)(((x.sup.j).sub.L), ((x.sup.j).sub.H)) = (c.sub.L)((x.sup.j).sub.L) + (c.sub.H)((x.sup.j).sub.H) + K.

Given an excise tax level (T.sub.e) and sales tax rate (T.sub.s), station A's problem in the symmetric case can be written as

(1) (max.sub.((p.sup.A).sub.L),((p.sup.A).sub.H)) ((pi).sup.A) = (((p.sup.A).sub.LN) - (c.sub.L))((S.sup.A).sub.L)
+ (((p.sup.A).sub.HN) - (c.sub.H))((S.sup.A).sub.H) - K,

where ((p.sup.A).sub.LN) = (((p.sup.A).sub.L)/(1 + (T.sub.s))) - (T.sub.e) and ((p.sup.A).sub.HN) = (((p.sup.A).sub.H)/(1 + (T.sub.s))) - (T.sub.e) denote station A's prices net of excise and sales taxes for low- and high-grade gasoline, respectively, and ((S.sup.A).sub.L) and ((S.sup.A).sub.H) denote the respective sales of low- and high-grade gasoline by station A. Sales of low- and high-grade gasoline are given by

(2) ((S.sup.A).sub.L) = (N/D)(t.sub.L) (((integral).sup.(s.sup.HA)).sub.s) dF(s) and
((S.sup.A).sub.H) = (N/D)(t.sub.H) (((integral).sup.s).sub.(s.sup.HA)) dF(s).

Note that in the symmetric case, the impact of consumers who switch between both stations and grades can be ignored. The first-order conditions for an interior solution are

(3) (partial)((pi).sup.A)/(partial)((p.sup.A).sub.L)
= ((S.sup.A).sub.L)/(1 + (T.sub.s)) + (N/D)
x ({f((s.sup.HA))((t.sub.H)(((p.sup.A).sub.HN) - (c.sub.H))
- (t.sub.L)(((p.sup.A).sub.LN) - (c.sub.L)))}/((q.sub.H) - (q.sub.L))
- ((((p.sup.A).sub.LN) - (c.sub.L))/2d) (((integral).sup.(s.sup.HA)).sub.s) dF(s))
= 0
(partial)((pi).sup.A)/(partial)((p.sup.A).sub.H)
= ((S.sup.A).sub.H)/(1 + (T.sub.s)) + (N/D)
x ({f((s.sup.HA))((t.sub.L)(((p.sup.A).sub.LN) - (c.sub.L))
- (t.sub.H)(((p.sup.A).sub.HN) - (c.sub.H)))}/((q.sub.H) - (q.sub.L))
-((((p.sup.A).sub.HN) - (c.sub.H))/2d (((integral).sup.s).sub.(s.sup.HA)) dF(s))
= 0.

Station B's problem is analogous to station A's. (8) The first-order conditions indicate that, in the pricing decision, the station takes into account that an increase in the price of either H or L raises profits from customers that continue to purchase the product, reduces profits to the extent that customers switch to purchasing the product from the competitor, and may either raise or lower profits for those who switch to purchasing the other grade depending on whether the margin for the other product is higher or lower. (9)

For a symmetric Nash equilibrium, (t.sub.i) = D/2, i = {L, H}, and prices ((p.sup.A).sub.LN), ((p.sup.A).sub.HN), ((p.sup.B).sub.LN), and ((p.sup.B).sub.HN) are defined by

((p.sup.A).sub.LN) = ((p.sup.B).sub.LN) = (c.sub.L) + (dD/(1 + (T.sub.s)))
((p.sup.A).sub.HN) = ((p.sup.B).sub.HN) = (c.sub.H) + (dD/(1 + (T.sub.s))).

Defining the margin differential between the two qualities as ((delta).sup.HL) = (((p.sup.A).sub.HN) - (c.sub.H)) - (((p.sup.A).sub.LN) -

(c.sub.L)), it follows that ((delta).sup.HL) = 0. Thus, in a symmetric Nash equilibrium, margins net of taxes are the same for each product yielding a margin differential, ((delta).sup.HL), of zero. (10) Additionally, the extent to which stations can set price (net of taxes) above marginal cost for each grade depends directly on the distance between stations, D, and the per unit distance travel cost, d. The intuition behind these results is straightforward. A reduction in the distance between stations (or, equivalently, a reduction in travel costs) equates to an increase in the number of consumers who will defect to the competitor for a given price increase. This induces the station to choose a lower price. In the limit, as D or d goes to zero, the Bertrand outcome of price (net of taxes) equal to marginal cost is obtained.

To understand why margins are identical across products as well as anticipate how our two modifications of the benchmark model can lead to differences in margins, it is useful to adopt the approach of Holmes (1989). Holmes presents an **analysis** of third-degree price discrimination in terms of two conceptually distinct elasticity components. In our context, there are three elasticity components to consider. These derive from dividing the reduction in sales due to an increase in the price of quality i into three parts: the reduction in the sales of the quality i good by firm j reflecting a decrease in quantity demanded at the market or "industry" level ((partial)((S.sup.jI).sub.i)/(partial)((p.sup.j).sub.i)); the reduction in the sales of the quality i good by firm j reflecting an increase in sales of the competitor's product ((partial)((S.sup.jC).sub.i)/(partial)((p.sup.j).sub.i)); and the reduction in the sales of the quality i good by firm j reflecting an increase in sales of the other quality good sold by firm j ((partial)((S.sup.jO).sub.i)/(partial)((p.sup.j).sub.i)). In terms of elasticities, these three components of sales changes are captured by the "industry-demand price elasticity,"

(((epsilon).sup.jI).sub.i) = -((partial)((S.sup.jI).sub.i)/(partial)((p.sup.j).sub.i))(((p.sup.j).sub.i)/((S.sup.j).sub.i)) (greater than or equal to) 0;

the "competitor cross-price elasticity,"

(((epsilon).sup.jC).sub.i) = -((partial)((S.sup.jC).sub.i)/(partial)((p.sup.j).sub.i))(((p.sup.j).sub.i)/((S.sup.j).sub.i)) (greater than or equal to) 0;

and the "own cross-price elasticity,"

(((epsilon).sup.jO).sub.i) = -((partial)((S.sup.jO).sub.i)/(partial)((p.sup.j).sub.i))(((p.sup.j).sub.i)/((S.sup.j).sub.i)) (greater than or equal to) 0. (11)

Using the three elasticity measures and assuming symmetry across firms, the first-order conditions with respect to the prices of the low and high grades of gasoline for firm A from equation (3) can be expressed as

(4) 1/(1 + (T.sub.s)) - (1/((p.sup.A).sub.L))(((((epsilon).sup.AI).sub.L) + (((epsilon).sup.AC).sub.L))

x(((p.sup.A).sub.LN) - (c.sub.L)) - (((epsilon).sup.AO).sub.L)((delta).sup.HL)) = 0

1/(1 + (T.sub.s)) - (1/((p.sup.A).sub.H))(((((epsilon).sup.AI).sub.H) + (((epsilon).sup.AC).sub.H))

x(((p.sup.A).sub.HN) - (c.sub.H)) - (((epsilon).sup.AO).sub.H)((delta).sup.HL)) = 0.

In the benchmark case just considered, price changes do not affect industry demand for either quality product ((((epsilon).sup.AI).sub.L) = (((epsilon).sup.AI).sub.H) = 0), and the competitor cross-price elasticities of demand divided by the price for the low- and high-quality goods are identical: (((epsilon).sup.AC).sub.L)/((p.sup.A).sub.L) = (((epsilon).sup.AC).sub.H)/((p.sup.A).sub.H) = 1/dD. Thus, it follows that the difference in margins across gasoline grades, ((delta).sup.HL) = (((p.sup.A).sub.HN) - (c.sub.H)) - (((p.sup.A).sub.LN) - (c.sub.L)), equals

zero.

Equation (4) suggests that differences in margins across grades require differences in the sum of industry-demand and competitor cross-price elasticities. One way to generate such differences, suggested by Katz (1984), is to assume that the per-unit distance cost of travel, d, is positively correlated with the **value** an individual places on quality, s. This captures the idea that those who place a greater **value** on increased quality tend to have higher incomes and thus tend to have higher search costs. Section B demonstrates that in our spatial duopoly model such an assumption leads to a higher competitor cross-price elasticity of demand for the low-grade gasoline ($\varepsilon^{AC}_L > \varepsilon^{AC}_H$). From equation (4) it follows that there will be a margin differential between premium and regular unleaded.

However, there is a second way to extend the benchmark model to generate a margin differential. Namely, we drop the assumption of a sufficiently high reservation price such that there is no consumer exit from the market. When the option of not buying is introduced, a difference in margins between premium and regular unleaded emerges. In terms of equation (4), with consumer exit, the industry price elasticity of demand is no longer zero for the low-quality product. It remains zero for the high-quality product, however, as such individuals, if they stop purchasing the high-quality product, revert to buying the low-quality product rather than exiting the market. Section C develops such an approach, one that results in differences in industry-demand elasticities across grades, specifically $\varepsilon^{AI}_L > \varepsilon^{AI}_H = 0$, such that the higher grade has a higher margin. Section D extends this **analysis** from two to three qualities to provide some insight into the effe ct on the margins of the low and high grades of gasoline of adding a third intermediate-quality good, namely, midgrade gasoline.

The Case of Correlated Travel Costs

This section assumes that the per unit distance cost of travel is directly correlated with the **value** an individual places on quality. This reflects the idea that individuals with high incomes place a higher **value** on quality and have higher search costs. A simple functional form for travel costs that captures this view is to assume a per-unit distance travel cost of $d(e^{\alpha s})$, where $\alpha \geq 0$. (12) The previous benchmark case can then be viewed as the special case of $\alpha = 0$. For $\alpha > 0$, the sales of the two products for station A are given by

$$S^A_L = (N/D) \int_{s}^{s^{HA}} (t_L)\, dF(s) \text{ and}$$

$$S^A_H = (N/D) \int_{s^{HA}}^{s} (t_H)\, dF(s),$$

where

$$t^i = (p^B_i - p^A_i)/2d(e^{\alpha s}) + D/2.$$

It is straightforward to show that with this addition the competitor cross-price elasticity with respect to the high-grade product is below that of the low-grade product. In particular, we have

$$\varepsilon^{AC}_L / p^A_L = (e^{-\alpha s} - e^{-\alpha s^{HA}})/dD(\alpha(s^{HA} - s))$$

and

$$\varepsilon^{AC}_H / p^A_H = (e^{-\alpha s^{HA}} - e^{-\alpha s})/dD(\alpha(s - s^{HA})).$$

It is clear that if $\alpha = 0$, then we have the benchmark case of identical elasticities per dollar's worth of each type of good. (13) However if $\alpha > 0$, indicating that those who place a higher **value** on increased quality have greater transportation costs, then it follows that $\varepsilon^{AC}_L / p^A_L$

(greater than) (((epsilon).sup.AC).sub.H)/((p.sup.A).sub.H). Given zero industry-demand elasticities for both grades, it follows from equation (4) that the symmetric equilibrium will yield a margin for the high-grade gasoline greater than that of the low-grade gasoline.

With the emergence of a margin differential, several issues arise. First, the magnitude of the own cross-price elasticity, (((epsilon).sup.jO).sub.i), now matters. In fact, given that the two products are substitutes, the presence of a second grade of gasoline results in higher margins for the lower grade and lower margins for the higher grade. The reason is simple. With a higher margin for the high grade, there is now a gain to raising the price of the lower grade to the extent to which it results in shifting buyers to the higher grade with the higher margin. Similarly, lowering the price of the high grade has an advantage of encouraging switches from the lower grade to the higher grade, which is the grade with the higher margin.

With a margin differential, we can also ask how this difference in margins is affected by such factors as the distance between stations, travel costs, the distribution of consumers' taste for quality, changes in wholesale costs, and the absolute difference in quality levels. Assuming a symmetric equilibrium, we can obtain explicit numerical solutions for this model for a wide range of parameters. Though the exact solution naturally depends on the parameters chosen, several results emerge. (14) The margin differential between the two grades of gasoline (((delta).sup.HL)) depends directly on the absolute difference in the quality levels of the two grades offered ((q.sub.H) - (q.sub.L)); directly on the average benefit to an incremental increase in quality, (s - s)/2; inversely on the marginal cost of the high-quality good ((c.sub.H)); directly on the marginal cost of the low-quality good ((c.sub.L)); directly on the distance between sellers, D, or travel cost parameter, d; directly on excise taxes ((T.sub.e)); and inversely on sales taxes ((T.sub.s)).

Relaxing the Full-Coverage Assumption

We now introduce the potential for consumers to choose to not buy, that is, to exit the market. For this case of incomplete market coverage, we assume that travel costs are identical across consumers; that is, (alpha) = 0. The quality preference parameter that makes the consumer at station j just indifferent between buying regular unleaded and exiting the market is defined by

(s.sup.j)(t) = (((p.sup.j).sub.L) + d(t.sup.j) - w)/(q.sub.L),

where (t.sup.j) is the distance between a consumer located at t and station j. We have defined (t.sub.L) as the market boundary between firms for consumers of regular unleaded gasoline. At this point, the taste for quality parameters for a consumer just indifferent between buying regular from station A or station B and exiting the market are given by

(s.sup.A)((t.sub.L)) = (((p.sup.A).sub.L) + d(t.sub.L) - w)/(q.sub.L)

(s.sup.B)((t.sub.L)) = (((p.sup.B).sub.L) + d(D - (t.sub.L)) - w)/(q.sub.L),

respectively. Given their location and taste for quality, purchases by different individuals from stations A and B are shown in Figure 3 for the case in which (t.sub.L) (greater than) (t.sub.H).

With the potential for consumers to exit the market, station A's pricing problem in the symmetric case can be written as in equation (1), but now the sales of the low- and high-grade gasoline, ((S.sup.A).sub.L) and ((S.sup.A).sub.H), respectively, are given by

(5) ((S.sup.A).sub.L) = (N/D) ((((integral).sup.(t.sub.L)).sub.0) (((integral).sup.(s.sup.A)((t.sub.L))).sub.(s.sup.A)(t)) dF(s)dt

+ (t.sub.L) (((integral).sup.(s.sup.HA)).sub.(s.sup.A)((t.sub.L))) dF(s)) and

((S.sup.A).sub.H) = (N/D)(t.sub.H) (((integral).sup.s).sub.(s.sup.HA)) dF(s).

Note that the above demand expressions assume that the two stations are sufficiently close that they compete for consumers in both grades of

gasoline, not just the higher grade. That is, not only are some consumers of station A's low-grade gasoline indifferent between purchasing and exiting the market but there are some low-grade consumers of station A who are indifferent between purchasing the lower grade from station B rather than from station A.

A comparison of the demands faced by stations with and without the exit option (the sets of equations (2) and (5), respectively) highlights an important difference. Namely, when we introduce the potential for consumer exit into the **analysis**, the relative sensitivity of demand to a price change for the lower-grade product increases. Now a price increase for the lower-grade product results in not only the loss of customers to the second firm, as would occur for the higher-grade product, but also the loss of customers as some exit the market. The result, as we show later, is that the optimal margin for the lower-grade gasoline will be smaller.

To determine the relative sizes of product margins, we again start with the first-order conditions with respect to prices:

$$\frac{\partial \pi^A}{\partial p^A_L} = \frac{S^A_L}{1 + T_s} + \frac{N}{D} \times \frac{\{f(s^{HA})(t_H(p^A_{HN} - c_H) - t_L(p^A_{LN} - c_L))\}}{q_H - q_L} - \frac{p^A_{LN} - c_L}{2d}\left(\int_{s^A(t_L)}^{s^{HA}} dF(s)\right) - \frac{N}{D(q_L)}(p^A_{LN} - c_L)\left(\int_0^{t_L} f(s^A(t))\, dt\right) = 0$$

and

$$\frac{\partial \pi^A}{\partial p^A_H} = \frac{S^A_H}{1 + T_s} + \frac{N}{D} \times \frac{\{f(s_{HA})(t_L(p^A_{LN} - c_L) - t_H(p^A_{HN} - c_H))\}}{q_H - q_L} - \frac{p^A_{HN} - c_H}{2d}\left(\int_{s^{HA}}^{s} dF(s)\right) = 0.$$

Again, assuming a symmetric equilibrium, we can obtain explicit numerical solutions for this model for a wide range of parameters. First, with consumer exit, it is no longer the case that identical margins satisfy the first-order conditions for prices. In fact, assuming a uniform distribution for the taste parameter, it can be shown that the margins that satisfy the "no exit" first-order conditions for prices in the symmetric case will now not satisfy the first-order condition for the price of the low-quality good given above. The consumer exit option introduces an extra gain to reducing the price (and thus margin) for the lower-grade good. The result is that the symmetric equilibrium has different margins across different grades of gasoline. In terms of equation (4), while the industry elasticity for the high grade remains zero ($\varepsilon^{AI}_H = 0$), it is positive for the low grade. In particular, although the competitor cross-price elasticity is lower for the low grade than for the high grade with consumer exit, this is outweighed by the introduction of a positive industry-demand price elasticity for the low grade. Specifically, we have $(\varepsilon^{AI}_L + \varepsilon^{AC}_L)/P^A_L = (\varepsilon^{AC}_H / P^A_H) + 3D/(8 q_L (s - s) S^A_L)$. The fact that the sum of the industry elasticity and the competitor cross-price elasticity for the low grade exceeds that for the high grade implies from equation (4) a higher margin for the high-grade product.

As before, with the emergence of a margin differential, a higher own cross-price elasticity, ε^{jO}_i, now results in higher margins for the lower grade and lower margins for the high grade. As before, with a margin differential, we can also now ask questions

concerning how this difference in margins is affected by such factors as the distance between stations, travel costs, the distribution of consumers' taste for quality, changes in wholesale costs, and the absolute difference in quality levels. As it turns out, the comparative static results concerning the margin differential are qualitatively identical to those for the correlated travel cost case. In particular, the margin differential between the two grades of gasoline depends directly on the absolute difference in the quality levels of the two grades offered, directly on the average benefit to an incremental increase in quality, inversely on the marginal cost of the high-quality good, directly on the marginal cost of the low-qualit y good, directly on the distance between sellers or the per unit distance cost of travel, directly on excise taxes, and inversely on sales taxes.

Introducing an Intermediate-Quality Product without Full Coverage

In the gasoline market, many stations sell not two but three grades of gasoline: regular, midgrade, and premium. It is therefore of interest to determine the effect of introducing an intermediate-quality product into our **analysis**. For tractability, our **analysis** of three grades adopts the case of consumer exit without correlated travel costs. Figure 4 illustrates a potential division of consumers across two sellers when there are three grades (i = H, M, and L). Note that with the midgrade option several new variables emerge. For instance, we now define the cut-off levels for the taste parameter, s, at which an individual is indifferent between regular and midgrade and between midgrade and premium at station j as

(s.sup.Hj) = (((p.sup.j).sub.H) - ((p.sup.j).sub.M))/((q.sub.H) - (q.sub.M)) and

(s.sup.Mj) = (((p.sup.j).sub.M) - ((p.sup.j).sub.L))/((q.sub.M) - (q.sub.L)),

respectively, where ((p.sup.j).sub.M) is the price of the midgrade gasoline at station j, and (q.sub.M) is the quality of the midgrade gasoline, with (q.sub.H) (greater than) (q.sub.M) (greater than) (q.sub.L) (greater than) 0. Similarly, by equating the surplus derived from buying gasoline of quality i from station A with that derived from buying gasoline of the same quality from station B, we can define the locations from station A at which consumers will switch between each of the three grades by

(t.sub.i) = (((p.sup.B).sub.i) - ((p.sup.A).sub.i))/2d+D/2, i = L, M, and H.

There are three interesting features of an **analysis** that includes a good with an intermediate level of quality. The first, a robust result, is that higher-quality goods have higher margins. That is, for all parameter values examined, we find that the predicted margin on the high-quality good (premium unleaded gasoline in this context) is greater than that for the middle quality, which in turn is greater than the margin for the low-grade of gasoline, regular unleaded. (15) The reason for this is apparent if one considers instead the situation in which the margin for midgrade unleaded equals the margin for the low-grade gasoline or equals the margin for the high-grade gasoline.

If the midgrade margin equals the margin for low-grade gasoline, then profits would not fall from an increase in the midgrade margin due to individuals switching from purchasing midgrade to low-grade gasoline. But profits would clearly increase from individuals switching from purchasing the midgrade gasoline to purchasing the high-grade gasoline, which has a larger margin. Thus, the midgrade margin will be greater than the low-grade margin. If the midgrade margin equals the margin for the high-quality product, then profits would not fall from a decrease in the midgrade margin due to individuals switching from purchasing the high-grade to the midgrade gasoline. But profits would clearly increase from individuals switching from purchasing the low-grade gasoline to the midgrade gasoline, which has a higher margin. Thus, the midgrade margin will be less than the high-grade margin.

A second, less clear-cut finding is the effect of the introduction of a midgrade gasoline on the margin differential between the highest- and lowest-quality grades. Numerical simulations indicate ambiguity. Depending on the position of the midgrade quality parameter (q_M), relative to the quality parameter for the low and high grades (q_L and q_H, respectively) and on the position of the cost of the midgrade quality (c_M) relative to the costs of the other two grades, the premium-regular margin differential can increase or decrease. A final finding, and one important for the empirical **analysis** to follow, is that the introduction of a midgrade product does not overturn the remaining comparative static results summarized in the previous sections.

III. EMPIRICAL TEST USING LOS ANGELES AREA DATA

The models presented in section II that assume either correlated travel costs or consumer exit generate a number of predictions with respect to margins and margin differentials. It is likely that the key elements of both models that generate margin differentials are relevant to an explanation of existing differentials. (16) However, the models do more than simply predict margin differentials. They also have specific predictions concerning the effect of taxes, income, and distance between stations on both margins and margin differentials. To test these predictions, we use a data set of retail and wholesale gasoline prices from the Los Angeles Basin area from 1992-1995. We focus our attention on margins calculated using cash retail prices for self-service regular unleaded and premium unleaded grades of gasoline and on the margin differential between these products. (17)

By focusing on self-service, cash retail prices for gasoline, we can compute a relatively clean measure of margin differentials across grades using the wholesale prices of the respective grades and the prevailing federal, state, and local taxes. Restricting our **analysis** to self-service gasoline allows us to abstract from factors affecting margins that might arise from having an attendant service the automobile. Restricting our **analysis** to unleaded grades allows us to abstract from potential differences that exist between the markets for leaded versus unleaded gasoline. For instance, Lott and Roberts (1991) argue that because cars using leaded gasoline have, on average, larger gas tanks than cars using unleaded gasoline, fixed costs are spread over more gallons, reducing the effective price to consumers of leaded gasoline. (18)

Empirical Model

In this section, we develop various measures for the factors that the theory suggests influence gasoline margins and test the predictions of the model using station-level data from the Los Angeles Basin retail gasoline market from 1992-1995. Section II describes models in which a multiproduct duopolist sets prices for products that differ in quality while facing a distribution of consumers who differ in their willingness to pay for quality. Both the model with consumer exit and the model assuming correlated travel costs suggest that both margins and margin differentials between grades depend on the difference in quality levels, the average taste for quality, the proximity of rival stations, wholesale prices, taxes, and the presence of midgrade unleaded gasoline.

The first factor to be considered is variation in the quality difference between the two grades of gasoline ($q_H - q_L$). Unfortunately, such variations are difficult to measure. We still must take care to control for potential changes in quality differences across stations. To do so, we restrict our **analysis** to include only those prices and costs associated with minimum octane ratings of 87 and 92, the standard octane levels in the Los Angeles market for regular and premium unleaded gasoline, respectively. (19) In addition to higher levels of octane, premium unleaded gasoline often contains additives, such as engine cleaners, that are brand specific. These additive packages may influence consumers' perceptions of product quality. To control for any resulting brand-fixed effects associated with the pricing of gasoline, we include in our empirical **analysis** variables indicating the

various brands of gasoline in the market. The remaining unexplained differences in margins cannot then be viewed as the outcome of variation in the quality differential.

A second factor the theory indicates can affect margin differentials is a change in consumers' "average" taste for quality reflected in the model by a change in the mean of the distribution of the taste for quality, (s -- s)/2. One proxy for a change in the average **value** placed on quality increments is a change in the income of potential consumers. This follows from the presumption that quality is a normal good. Additionally, it is reasonable to expect income levels to be positively correlated with search costs, which our model has shown to be an important factor in generating margin differentials. (20)

To calculate a measure of consumer income for a particular station, we face the difficult task of identifying its potential consumers. Many gasoline buyers purchase gasoline near their residence, whereas others may regularly purchase gasoline away from home, possibly on a commuter route. Though these differences in buying patterns should ideally be taken into account when calculating an income measure for potential customers of a station, this is not a simple task. However, to the extent gasoline buyers tend to buy gasoline from a station near their residence, we can construct such an income measure. In particular, from census data we calculate the median income of households within a radius of z miles around any given station, where the radius, z, takes on the **value** of 0.5, 1.0, or 2.0 miles. (21)

Four other factors that our model has shown can affect regular and premium margins as well as the margin differential between premium and regular gasoline are the marginal costs of the different grades of gasoline ((c.sub.L) and (c.sub.H)), the level of excise taxes ((T.sub.e)), the distance to the competing station (D), and the presence of midgrade gasoline. We use wholesale prices for each brand to proxy for a station's marginal cost of the different grades of gasoline and the sum of federal and state excise taxes to capture tax effects on margins. A simple proxy for the distance measure is the distance to each station's closest rival. (22) Finally, we include a dummy variable that indicates the presence of midgrade unleaded gasoline at the sampled station. (23)

Define (((delta).sup.R).sub.jt), (((delta).sup.P).sub.jt), and (((delta).sup.PR).sub.jt) as, respectively, the real, after-tax margin for regular gasoline; the real, after-tax margin for premium gasoline; and the margin differential between premium and regular gasoline for station j, at time t. Note that (((delta).sup.PR).sub.jt) = (((delta).sup.P).sub.jt) - (((delta).sup.R).sub.jt). The equations to be estimated can be written as

(6) (((delta).sup.(theta)).sub.jt) = (((alpha).sup.(theta)).sub.0) + (((alpha).sup.(theta)).sub.1)(INCOME.sub.j)
+ (((alpha).sup.(theta)).sub.2)(WPR.sub.jt) + (((alpha).sup.(theta)).sub.3)(WPP.sub.jt)
+ (((alpha).sup.(theta)).sub.4)(EXCISE.sub.t) + (((alpha).sup.(theta)).sub.5)(MID.sub.jt)
+ (((alpha).sup.(theta)).sub.6)(DISTANCE.sub.jt) + ((delta).sub.(theta))B
+ ((gamma).sup.(theta))M + (((epsilon).sup.(theta)).sub.jt), (theta) = {R, P, PR},

where (INCOME.sub.j) is the 1990 median household income of station j's potential consumers as defined by a fixed radius around station j; (WPP.sub.jt) is the real wholesale price of premium gasoline and (WPR.sub.jt) is the real wholesale price of regular gasoline for station j in period t; (EXCISE.sub.t) is the total (federal and state) excise tax at time t; (DISTANCE.sub.jt) is the physical distance (in tenths of miles) from station j to its closest competitor in period t; and (MID.sub.jt) is a dummy variable set equal to one if station j offered midgrade unleaded gasoline in period t, zero otherwise. The term B' = ((B.sub.1),..., (B.sub.d),..., (B.sub.y)) represents brand effects for the y different brands, where (B.sub.d) is a zero--one dummy variable set equal to one if

station j carries brand d, zero otherwise. Finally, the term M' = ((M.sub.1),..., (M.sub.r),..., (M.sub.v)) represents market-fixed effects not captured by income, where (M.sub.r) is a zero--one dummy variable set equal to one if sta tion j is located in market r, zero otherwise. We estimate market-fixed effects by including county-of-operation dummy variables in equation (6). These variables also capture market "ruralness," which could affect the distribution of stations, which in turn could have an impact on DISTANCE. We do not include sales taxes in our empirical model because variation in sales tax rates reflect cross-county differences. The effects of sales tax variation thus cannot be separated from other county effects. Finally, the error terms (((epsilon).sup.(theta)).sub.ij). (theta) = {R, P, PR}, are assumed to be normally distributed with zero mean and constant variance.

Finally, although the models in section II consider only the proximity of the closest station regardless of whether that station is an independent dealer or a major brand, we report estimates of the margin differential equation that explicitly allow these characteristics to affect price--cost margin differentials. In this second specification, we create five new variables. If the station being observed is an independent dealer, we calculate the effect of the proximity of its closest independent and major competitor, (24) Similarly, if the observed station is a major brand, we estimate the effect of the proximity of its closest independent competitor. Additionally, for major brands only, we calculate the effect of the proximity of the closest same-brand and other-brand rival.

In summary, the theory presented in section II predicts that with respect to the regular margin (((alpha).sup.R).sub.1) (greater than) 0, (((alpha).sup.R).sub.2) (less than) 0, (((alpha).sup.R).sub.4) (less than) 0, and (((alpha).sup.R).sub.6) (greater than) 0. With respect to the premium margin, the theory predicts that (((alpha).sup.P).sub.1) (greater than) 0, (((alpha).sup.P).sub.3) (less than) 0, (((alpha).sup.P).sub.4) (less than) 0, and (((alpha).sup.P).sub.6) (greater than) 0. Finally, with respect to the margin differential between premium and regular unleaded gasoline, the theory predicts that (((alpha).sup.PR).sub.1) (greater than) 0, (((alpha).sup.PR).sub.2) (greater than) 0, (((alpha).sup.PR).sub.3) (less than) 0, (((alpha).sup.PR).sub.4) (greater than) 0, and (((alpha).sup.PR).sub.6) (greater than) 0.

Data and Econometrics

We have obtained two data sets from Whitney-Leigh Corporation that, when combined, provide the empirical basis for testing. The first data set consists of a series of "market surveys" that contain detailed station characteristics on purportedly all of the more than 4,000 gasoline stations in the five-county region known as the Los Angeles Basin for the years 1992-1995 (25) These data include variables such as location by street address, city, county, ZIP code, brand affiliation, and octane levels on all grades.

The second data set is a series of bimonthly surveys of prices and gasoline sales for a subset of stations in the Los Angeles Basin area for the years 1992-1995. These "price surveys" were typically taken in January, March, May, July, September, and November of each year. There are several surveys, however, that occur in other months. These surveys are also included in the sample. (26) The price surveys provide detailed information on cash-only prices and gasoline sales, identifying gallons sold by grade of gasoline (regular and premium) and by type of service (full-service and self-service). Each price survey collects data on more than 600 of the more than 4,000 stations in the Los Angeles area. (27) These price surveys have been matched with the Los Angeles market survey data to yield a data set that combines the data on the prices charged at a particular station with that station's characteristics provided in the market surveys. (28) Finally, we have obtained wholesale prices, by brand, by grade, and by d ate, from Lundberg Surveys, Inc. (29)

Retail prices, wholesale prices, taxes, and incomes are adjusted to December 1995 prices using the Los Angeles CPI-U series. Federal and state

excise taxes, along with state and local sales taxes, were obtained from the California State Board of Equalization. Median income data were obtained from the 1990 Census Summary Tape File 3A. Finally, station addresses were used to plot station locations. Corresponding census tract numbers were recorded, and station locations were converted into latitude and longitude coordinates using the Census Bureau's LandView(TM) II mapping software.

Because the data are constructed longitudinally, the estimator used must account for the fact that there may be significant correlation between the errors associated with any given station in period t and period t + j, t (not equal to) j. The econometric results that we report are estimated by relaxing the assumption of independence between within-station errors but maintaining the assumption of independence across stations. Additionally, given the possibility of nonspherical disturbances, we employ the White (1980) estimator of variance to be used in place of the standard calculation. Robust standard errors are reported. (30)

The model to be estimated could be estimated using an error-components specification

((delta).sub.jt) = ((beta).sub.0) + ((beta).sub.1)(INCOME.sub.j) + (tau)(X.sub.jt) + (v.sub.j) + ((epsilon).sub.jt),

where (INCOME.sub.j) is time-invariant, (X.sub.jt) is a vector of time-varying regressors, (v.sub.j) is a residual specific to each station, and ((epsilon).sub.jt) is a residual which varies over time and stations. A **random**-effects specification is preferred to a fixed-effects specification because the coefficient on (INCOME.sub.j) is of interest and the fixed-effects estimator eliminates time-invariant variables. Because there are no station-invariant variables, equation (6) may be estimated with either the between-effects estimator or the **random**-effects estimator (a weighted average of the between-and fixed-effects estimators, where the weight depends on the variances of (v.sub.j) and ((epsilon).sub.jt)). Both estimators, however, require that (INCOME.sub.j) and (X.sub.jt) be uncorrelated with (v.sub.j). We tested the appropriateness of these specifications using a Hausman (1978) test and rejected the null hypothesis that (v.sub.j) and (X.sub.jt) were uncorrelated. We therefore do not adopt the error -components methodology. We resort to using an estimation technique that corrects for time-wise serial correlation and heteroskedasticity.

Results

Descriptive statistics for the Los Angeles Basin data are reported in the first column in Table II. Over the entire sample period, the premium unleaded margin averaged approximately 14.6 cents per gallon, and the regular unleaded margin averaged approximately 9.2 cents per gallon. The real after-tax price--cost margin differential between premium and regular unleaded gasoline, ((delta).sup.PR), averaged approximately 5.5 cents per gallon. The distance variable, DISTANCE, was calculated by taking the minimum distance, using station latitude and longitude as coordinates, between any sampled station and every competitor in the market. The average distance to the closest competitor is approximately 0.25 miles. Median household income averaged approximately $46,000 when calculated for a 1-mile radius around each station. Qualitative results are unaffected when this radius is changed to 0.5 or 2 miles; for brevity, only results from the 1-mile markets are reported. Finally, approximately 80% of the stations sampled offered midgrade unleaded gasoline.

Estimated coefficients of equation (6) are also found in Table II. As the models in Section II predict, as the distance between any given station and its closest competitor decreases, both regular and premium margins decrease. However, the premium margin falls at a greater rate, which leads to a decrease in the premium-regular margin differential. In particular, as the distance to the closest rival decreases by 0.1 mile, the premium-regular margin differential decreases by approximately 0.25 cents per gallon, other things equal. (31) When specific brand-related distance effects are included, we see that the most significant effects of rival

proximity appear for majors competing with an independent and for majors competing with another major. The effect of same-brand proximity does not appear to significantly impact margin differentials, but the proximity of another brand decreases margin differentials significantly.

The coefficients on median household income suggest that increases in market income levels do have a significant impact on margins and margin differentials. These results support the claim that as the average **valuation** for incremental increases in quality and/or search costs increase, differences in price-cost margins increase. In particular, as median income increases by $10,000, the margin differential between premium and regular increases by approximately 0.81 cents per gallon, holding other factors constant.

Other things being equal, stations offering midgrade unleaded gasoline have, on average, a 0.7-cent-per-gallon higher price-cost margin differential between premium and regular unleaded. As Table II reports, the presence of midgrade unleaded gasoline serves to decrease the regular unleaded margin and increase the premium margin, other things constant. Though the theory does not offer a clear-cut prediction concerning the effect of offering midgrade gasoline, the driving force for this finding may be the following. By offering midgrade unleaded, the station's cost of increasing its premium price is now relatively smaller given that marginal consumers will now switch to purchasing midgrade instead of regular; recall that the margin on midgrade is greater than that of regular. Similarly, in the presence of midgrade unleaded, the station's cost of increasing its regular unleaded price is now relatively greater. Consumers who would have switched to premium unleaded will now purchase midgrade unleaded, which earns a lower margin. Thus, the price-cost margin spread between premium and regular should increase.

As the theory predicted, Table II reports a positive relationship between excise taxes and the premium-regular margin differential. In particular, a 10-cent increase in excise taxes results in a 2.25-cent-per-gallon increase in the margin differential. As expected, increases in excise taxes reduce both premium and regular margins. The estimated coefficients indicate that a 10-cent increase in the excise tax increases the regular unleaded price by approximately 6.5 cents per gallon and increases the premium unleaded price approximately 8.75 cents per gallon. Borenstein et al. (1997) study the effects of changes in wholesale prices on corresponding retail prices and find that in general shocks are passed along with some significant lag, and, in addition, not all shocks are completely incorporated in the downstream price. Our estimates indicate the effect of a contemporaneous change in the excise tax on retail margins. It is not surprising, then, that only 65% and 87% of excise tax changes have been passed alon g to regular and premium consumers, respectively.

Finally, as expected, an increase in the premium unleaded wholesale cost significantly lowers the observed margin differential, whereas an increase in the regular unleaded wholesale cost significantly increases the difference in margins. As Table II reports, a 1-cent increase in the premium unleaded wholesale cost decreases the margin differential by approximately 0.76 cents per gallon, while a 1-cent increase in the regular unleaded wholesale cost increases the margin differential by approximately 0.71 cents per gallon. What is unexpected is the small and insignificant effect of the other grade's wholesale cost on the margins of each grade. The theory predicts dependent pricing of the two products because of consumers' willingness to switch, but the empirical results do not confirm this.

Overall, the theoretical results presented in section II are supported by the empirical work. Most important, we have shown that the margin differential between premium and regular unleaded gasoline depends on consumers' **valuation** for quality, indicating the importance of vertical product differentiation, and the proximity of rival stations, indicating the importance of horizontal product differentiation.

IV. CONCLUDING REMARKS

In this paper, we have developed a theory that integrates both horizontal and vertical product differentiation to explain quality-related differences in retail price margins. We have shown that price-cost margin differentials exist as long as either travel costs are positively correlated with consumers' **valuation** of quality or some consumers each period choose not to buy and exit the market. We tested our theory using station-level data from the Los Angeles retail gasoline market. It was demonstrated that margin differentials between premium and regular unleaded gasoline depend positively on potential consumers' income, the physical distance between competing stations, and excise taxes. Additionally, the ability of any gasoline station to price above marginal cost was shown to be a function of the proximity of rival stations. In particular, as the physical distance between rivals decreases, price- cost margins fall. This last finding is a rare direct test of the basic tenet of the often-used Hotelling model that distance from a competitor affects mark-ups.

Given that margins are higher for premium than for regular, one might ask why we do not observe stations specializing in the sale of premium gasoline. Given free entry and resulting zero profits, premium customers do subsidize regular customers in terms of their contributions per gallon toward fixed costs. Why don't new entrants take advantage of this situation by appealing only to the premium (high-quality) buyers? In our setting, the reason why this does not happen is clear. Such a specialist would be equivalent to an existing station choosing to offer only a single grade of gasoline. Yet this choice can be shown to result in lower profits as the seller misses the opportunity to appeal to buyers who **value** quality less. So, at least in our setting, we should not expect to see specialists selling only the high-margin, high-quality good. However, if there were no transportation charges, or equivalently no horizontal differentiation, such specialists could emerge to skim off the premium customers from many sta tions. But such a setting also implies identical margins across different grades, so premium customers would no longer be preferred.

Extensions to this research would examine such issues as the determination of location based on the number of different quality types as well as the determination of the gradation in quality of products offered for sale. Additionally, these data may prove to be useful in testing spatial theories of location in markets with free entry. (32) One interesting issue that we have not focused on is the effect that the heterogeneity of sellers has on margins and the margin differential. The model presumes competitors are differentiated only by location. However, in the gasoline market, products are also differentiated by major versus independent brands. From results not presented, we find that the distance between a major and the closest independent has the greatest effect on margins; a reduction in distance by one-tenth of a mile between a major-brand station and its closest independent competitor results in a decrease in the regular margin of 0.19 cents per gallon, a decrease in the premium margin of 0.40 cents pe r gallon, and a decrease in the margin differential of 0.21 cents per gallon. Of similar importance is the distance between two major-brand stations selling different brands; a reduction in distance by one-tenth of a mile between a station and its closest competitor when they are selling different major brands results in a decrease in the regular margin of 0.10 cents per gallon, a decrease in the premium margin of 0.39 cents per gallon, and a decrease in the margin differential of 0.29 cents per gallon. On the other hand, we find evidence that two stations selling the same major brand are located sufficiently distant from one another that a change in the distance separating such stations does not significantly affect margins or margin differentials.

(*.) We thank Pat McCarthy, Janet Netz, and an anonymous referee for helpful comments. Valuable research assistance was provided by Scott Blanchard and Shinfan Chang. We also thank seminar participants at Baylor University, Purdue University, and Western Washington University. An

earlier version of this paper was presented at the 1998 meetings of the Midwest Economic Association. **Financial** support was provided by the Purdue Research Foundation. Any errors of omission or commission are our own.

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(1.) The term margin is used to mean the retail price net of all federal, state, local excise, and local sales taxes minus the wholesale, or "dealer buying," price. The consumer price index was used to convert all retail margins into December 1995 dollars.

(2.) Two products are considered horizontally differentiated if they are differentiated on attributes over which consumers do not share similar preferences (e.g., size, color, or location). By contrast, two products are considered vertically differentiated if the products are differentiated on attributes over which consumers share common preferences (e.g., product quality). In other words, if offered at identical prices, all consumers would choose to consume products of higher quality over those of inferior quality. Examples of models used to describe horizontal differentiation include Hotelling (1929), d'Aspremont et al. (1979), Eaton and Wooders (1985), Economides (1989), Neven (1985), and Salop (1979). Examples of vertical differentiation models include Gabszewicz and Thisse (1979, 1980), Gabszewicz et al. (1986), Shaked and Sutton (1983), and Mussa and Rosen (1978). See also Katz (1984), Kwoka (1992), Oren et al. (1982), and Maskin and Riley (1984).

(3.) Nalebuff (1987) identifies this as one reason for the margin differential between premium and regular gasoline. Nalebuff also suggests that a second reason for the margin differential may be the use of regular gasoline as a loss leader. In this context, consumers are lured into a station with a low posted price for regular unleaded only to encounter substantially higher prices on higher-octane grades. However, in the Los Angeles region, the focal point of the empirical part of this study, retail stations are required to post prices for all grades of gasoline.

(4.) Travel costs that are correlated with the **value** individuals place on improved quality captures the presumption that those who place greater **value** on quality are more likely to be high-income individuals who have high search costs.

(5.) To our knowledge, the case of potential consumer exit from the market has not been considered elsewhere in this context.

(6.) In other words, the market coverage assumption is relaxed. Naturally, exiting the market in a given period need not imply that the consumer never purchases the product. Rather, one can consider consumer exit as reflecting a consumer who purchases less frequently.

(7.) In an article that looks at a very similar problem, Borenstein (1991) examined the observed margin differential between leaded and unleaded gasoline during the 1980s using a spatial model of horizontal differentiation. It is shown that margins on unleaded regular gasoline **historically** exceed margins on leaded regular gasoline. Borenstein argues that, because of higher average incomes and greater use of credit cards, unleaded gasoline purchasers are relatively more loyal to an individual station or brand or are less willing to search for lower prices. The distinction between this model and ours is that the two goods Borenstein examines, unleaded and leaded gasoline, are not considered by consumers to be vertically differentiated. Shepard (1991) considers vertically differentiated goods in the context of a station offering both full- and self-service gasoline and finds the potential for stations to

price discriminate based on consumers' willingness to pay for service. However, Shepard does not extend her a nalysis to include horizontal differentiation.

(8.) For Station B, (t.sub.L) and (t.sub.H) would be replaced by (D - (t.sub.L)) and (D - (t.sub.H)), respectively.later, at the optimal prices the two margins will be identical, so that the price increase decision simply reflects the trade-off between greater revenues from those who continue to buy the product against the loss in revenues from those who switch and purchase the same product from the other station.

(10.) Gilbert and Matutes (1993) point out that station profits in this differentiated product market are not globally concave. Uniformity of the distribution of s is shown to be a sufficient condition for existence of an equilibrium as characterized above. However, one cannot rule out existence of other equilibria of this simultaneous move game, although if such equilibria exist, they must be asymmetric when s is uniformly distributed.

(11.) Note that Holmes does not identify this third elasticity component as he considers only single-product firms.

(12.) We continue to assume that the basic willingness-to-purchase parameter, w, is sufficiently large to ensure that all N potential consumers have a nonnegative surplus from one of the two qualities at prevailing prices.

(13.) To see this, note from L'Hospital's Rule that (lim.sub.(alpha)(right arrow)0)((((epsilon).sup.AC).sub.i)/((p.sup.A).sub.i) = 1/dD.

(14.) The results reflect the outcome of numerical simulations performed using Mathematica 3.0. The simulations use actual average real wholesale prices, taxes, and distance between stations for the data set under consideration. Free parameters (including the **value** of the different qualities, (q.sub.i), the willingness-to-pay parameter, w, and the upper and lower bounds for the uniform distribution of the taste parameter, s) were chosen to mimic the proportion of sales of the two grades of gasoline. Unless otherwise noted, the results reported are robust to a number of different specifications of these parameters. A sample of the simulation output is available from the authors on request.

(15.) For simplicity, as before, we restrict our **analysis** to the symmetric case.

(16.) Though the different specifications of our benchmark model generate differences in margins between regular and premium unleaded gasoline, we are unable to differentiate empirically between the models.

(17.) Similar tests using the premium-midgrade and midgrade-regular margin differentials are available from the authors. Results are robust across specifications.

(18.) All consumers in our model are potential buyers of either grade of gasoline. As such, differences in gasoline tank size and the like do not affect the relative "effective" price of different grades of gasoline.

(19.) A few gasoline stations offer different octane-grade labels. For instance, several gasoline stations in the data post an 89 minimum octane rating as "premium gasoline." Because some consumers may not notice octane variations but read only grade labels, the sample is restricted to the standard octane-grade labels mentioned.

(20.) Offsetting these two effects, an increase in income, if interpreted as an increase in consumers' basic willingness to pay, w, can reduce margin differentials. We estimate a positive coefficient on the income variable, which indicates that the average **valuation** for quality and search cost effects dominate.

(21.) Shepard (1991) and Netz and Taylor (2000) also utilize 0.5, 1, and 2-mile markets in examining issues related to price discrimination and location decisions in the gasoline industry.

(22.) We also included the average distance to each of the station's rivals in the defined market area and obtained similar qualitative results.

Because the distance to the closest rival more accurately matches our theory's specification, we report only the effect the distance to the closest rival has on margins and margin differentials.

(23.) In our data set, midgrade unleaded gasoline is defined as having a minimum octane rating of 89. Approximately 80% of the stations in the entire sample offer midgrade gasoline.

(24.) This is achieved by interacting a dummy variable, set equal to unity if the observed station is an independent dealer, with the appropriate distance.

(25.) The five counties are Los Angeles, Orange, San Bernardino, Ventura, and Riverside. Each station is surveyed once in the market survey. Therefore, the data on location, brand, and octane levels do not change within each year of our sample.

(26.) Data are missing for July 1995.

(27.) The panel is particularly stable. There are 812 unique stations that appear at least once in the price surveys. Of these 812 stations, 626 stations (77.1%) appear in every year of the sample. Percentages of stations appearing in only 3, 2, or 1 year(s) in the sample are 8%, 6.5%, and 8.4%, respectively.

(28.) Each station surveyed by Whitney-Leigh has a unique station ID. We simply matched station IDs from both surveys to obtain our data set.

(29.) Wholesale prices are dealer buying prices from Lundberg. Lundberg surveys wholesale prices weekly by brand and by grade. We then matched these wholesale prices to our data set by matching dates, brands, and grades.

(30.) We do not include survey-date time dummy variables because any variation in taxes is due entirely to changes across time.

(31.) Several nonlinear specifications of the distance variable proved to be statistically insignificant.

(32.) See, for example, Netz and Taylor (2000).

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Industry Codes/Names: BUS Business, General
Descriptors: Gasoline industry--Prices and rates
Geographic Codes: 1USA United States; 1U9CA California
Product/Industry Names: 2911130 (Motor Gasoline)
Product/Industry Names: 2911 Petroleum refining
NAICS Codes: 32411 Petroleum Refineries
File Segment: TI File 148

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